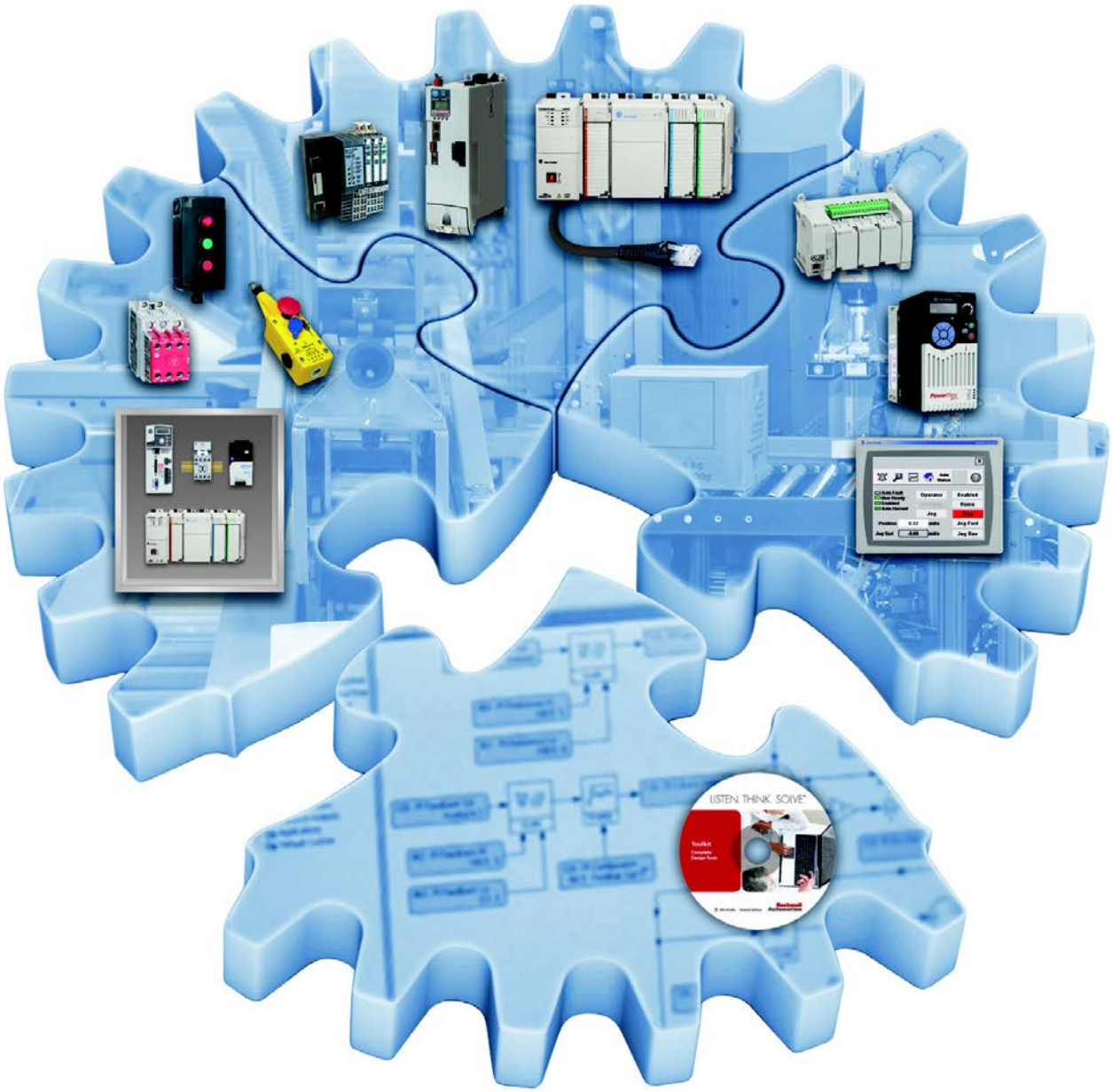
Quick Start

Allen-Bradley

Controller-based Temperature Control Application Building Block

Connected Components Accelerator Toolkit



Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

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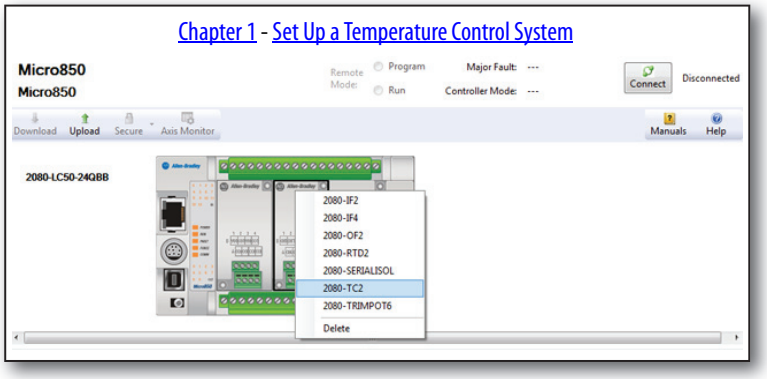
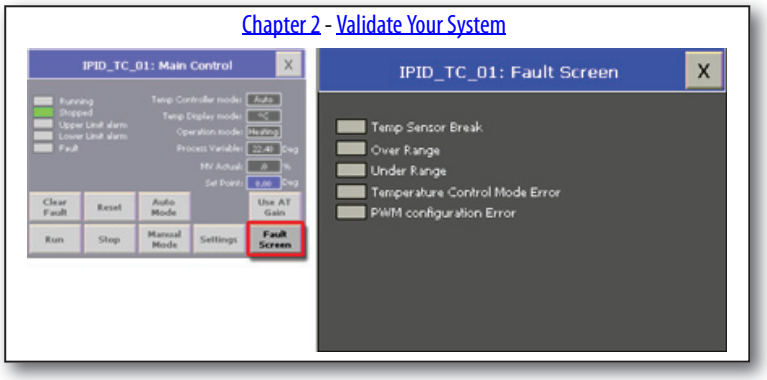
Follow this path to complete your building block project.

Read the Getting Started CCAT with System Design Assistant Quick Start, publication CC-QS035.

Chapter 1 - Set Up a Temperature Control System



Chapter 2 - Validate Your System



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About This Publication

This quick start is designed to provide a way to implement common control tasks by aiding in the selection of products and providing access to panel and wiring information. Each section is designed with a different task as a standalone machine, or implemented in a larger system.

IMPORTANT	Use this publication together with other Connected Components Accelerator Toolkit quick starts to aid in building your Micro800™ based application. Refer to Available Connected Components Accelerator Toolkits on page 9 for where to find other quick starts.

To help with the design and installation of your system, application files and other information are provided on the Connected Components Accelerator Toolkit (CCAT). The CCAT provides bills of materials (BOM), CAD drawings for panel layout and wiring, control programs, Human Machine Interface (HMI) screens, and more. With these tools and the built-in best-practices design, you are free to focus on the design of your machine control and not on design overhead tasks.

The CCAT is available on the Connected Components Accelerator Toolkit DVD, publication CC-QR002, or through the Rockwell Automation® Software Download and Registration System (SDRS) at http://www.rockwellautomation.com/rockwellautomation/products-technologies/connected-components/tools/accelerator-toolkit.page.

The beginning of each chapter contains the following information. Read these sections carefully before you begin work in each chapter:

- **Before You Begin** - The chapters in this quick start do not have to be completed in the order in which they appear. However, this section defines the minimum amount of preparation that is required before completing the current chapter.
- **What You Need** - This section lists the tools that are required to complete the steps in the current chapter, including, but not limited to, hardware and software.
- **Follow These Steps** - This section illustrates the steps in the current chapter and identifies the steps that are required to complete the examples.

Terminology

Term (abbreviation)	Definition
Application Sequence Programs	User-modified programs that work together with the standard state machine logic to control what the machine does while in the abort, clear, reset, run, and stop states.
Auto/manual operation	When the PanelView™ 800 terminal is in Auto mode, the controller logic controls the machine and monitors machine status. When the PanelView 800 terminal switches to Manual mode, the terminal takes over control. Command buttons and numeric entry fields are available only when the machine is in Manual mode.
Bill of Materials (BOM)	A list of components that are needed for your system.
Building block (BB)	Tools to accelerate and simplify the development of a Micro800 controller-based application. A typical building block includes a starting Bill of Material (BOM), Computer-Aided Design (CAD) drawings, Micro800 controller programs, PanelView 800 terminal applications, and a quick start document.
Computer-Aided Design (CAD)	A computer-based system that is developed to facilitate design of mechanical parts.
Connected Components Accelerator Toolkit (CCAT)	Software with application files and other information to speed the design and startup of component-based machines.
CCAT project	A project that consists of these items: • A ProposalWorks™-based bill of materials • A set of CAD drawings (dimensions and schematics) • A Connected Components Workbench project • HMI screens • A set of Quick Start documents • A project document with information about the project components and links to reference materials
Connected Components Workbench™ software	Software environment to configure or program Micro800 controllers, PanelView 800 terminals, PowerFlex® drives, and other component-level products.
Connected Components Workbench project	A project that consists of one or more of these items: • Micro800 controller configuration • Up to 256 Micro800 programs, each with program local variables • Micro800 global variables • PanelView 800 terminal application • PowerFlex drive parameter lists
Global variables	Project variables that any program can access, which includes all I/O and system variables.
State Machine control code	Machine logic to coordinate overall machine operation that is based on states. The state machine broadcasts commands and receives feedback information from each of the building blocks via user-modified application sequence programs.
Tags	A PanelView 800 term for variables.
User-defined Function Blocks (UDFBs)	Function block instructions that can be used like standard function block instructions within any Connected Components Workbench programming language. Anyone who uses Connected Components Workbench software can write these functions blocks. Many UDFBs are posted on the Rockwell Automation sample code website: http://samplecode.rockwellautomation.com/idc/groups/public/documents/webassets/sc_home_page.hcst.
User-defined Object (UDO)	A collection of PanelView 800 terminal screen objects that can be pasted into a new screen.

Available Connected Components Accelerator Toolkits

For the most up-to-date listing of available Connected Components Accelerator Toolkits and related quick starts, refer to these resources:

- Rockwell Automation Connected Components Accelerator Toolkit website at http://www.rockwellautomation.com/rockwellautomation/products-technologies/connected-components/tools/accelerator-toolkit.page
- Connected Components Accelerator Toolkit Building Block Project Descriptions Quick Reference, publication CC-QR003

Additional Resources

These resources contain information about related products from Rockwell Automation.

Resource	Description
Micro820™ 20-point Programmable Controllers User Manual, publication 2080-UM005	Provides a reference guide for Micro820 controller systems. It also contains procedures to install, wire, and troubleshoot your controller.
Micro830™ and Micro850™ Programmable Controllers User Manual, publication 2080-UM002	Provides information to install, wire, and troubleshoot the Micro830 and Micro850 programmable controllers.
Micro800 Digital and Analog Plug-in Modules and Accessories User Manual, publication 2080-UM004	Provides information to install, wire, and troubleshoot Micro800 plug-in modules and accessories.
PanelView 800 HMI Terminals Installation Instructions, publication 2711R-IN001	Provides information to install, wire, ground, and troubleshoot PanelView 800 HMI terminals.
PanelView 800 HMI Terminals User Manual, publication 2711R-UM001	Provides information to configure, operate, and troubleshoot the PanelView 800 HMI terminals.

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Notes:

Set Up a Temperature Control System

This chapter guides you through setting up a temperature control system with a Micro800 controller that uses the supplied device-building block sample code. The sample code can accept a wide range of temperature sensor input, as well as provide analog and Pulse Width Modulation (PWM) control output to suit your application needs.

Micro850 controllers are referenced throughout this document. Wherever a Micro850 controller is referenced, a Micro820 or Micro830 controller can also be used.

Before You Begin

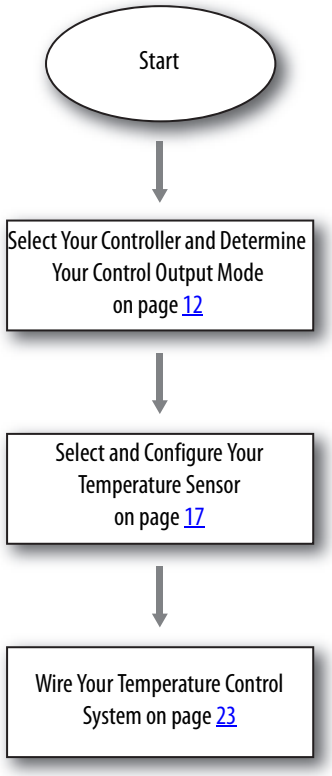
Review the Getting Started CCAT with System Design Assistant, publication CC-QS035.

What You Need

- Windows-based personal computer with Internet access
- Connected Components Workbench software, version 6 or later
- Micro800 controller (transistor output type preferred)
- Supported temperature sensor
- Heating or cooling device
- Thermocouple or RTD plug-ins
- Analog output plug-ins (for analog control)
- USB programming cable (A to B) for personal computer to Micro800 communication

Follow These Steps

Follow these steps to configure your Controller-based Temperature Control Application Building Block.


Start
Select Your Controller and Determine Your Control Output Mode on page 12
Select and Configure Your Temperature Sensor on page 17
Wire Your Temperature Control System on page 23

Select Your Controller and Determine Your Control Output Mode

Depending on your application, you can use analog or PWM Control. The sample code is designed for both control modes. We recommend that you use a transistor output type controller if you prefer PWM Control mode.

Analog Control Mode

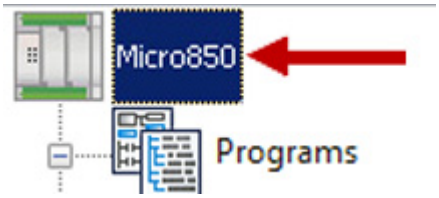
Follow these steps if analog is your preferred control mode; see page 15 if PWM is your preferred control mode.

1. Start the supplied IPID Temperature Controller Building Block project for your specific Micro800 controller with the Connected Component Workbench software.

   If necessary, use controller type change to match your Micro800 controller catalog number. Refer to the software help for instructions on controller type change.

2. In your Project Organizer, double-click the Micro800 controller icon to launch the controller configuration screen.

   This examples shows a Micro850 controller.

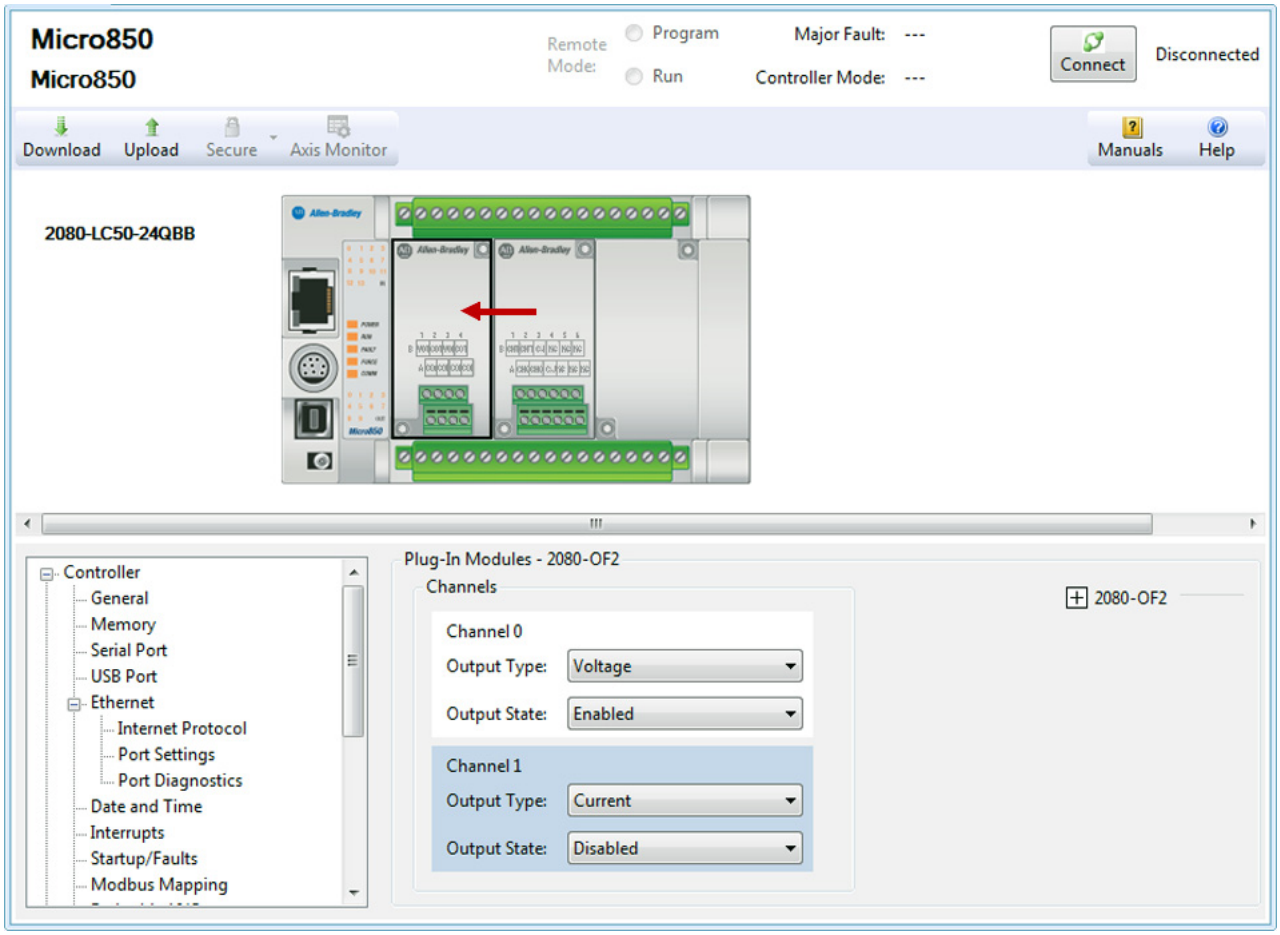


The Controller Detail view appears in the main project window. By default, an analog output plug-in (2080-OF2) has been configured for you in slot 1.

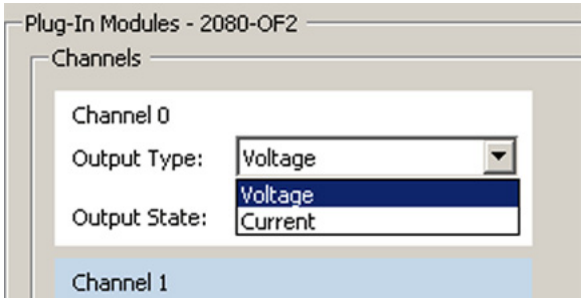
ATTENTION: When a project is created with the CCAT generation function, no plug-in module is configured. You must add and configure the plug-in manually.

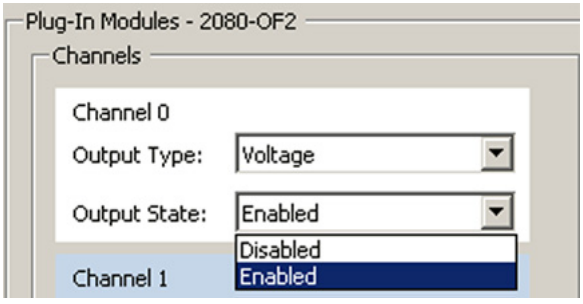
Refer to the default configuration described in the following steps.

3. Click slot 1.



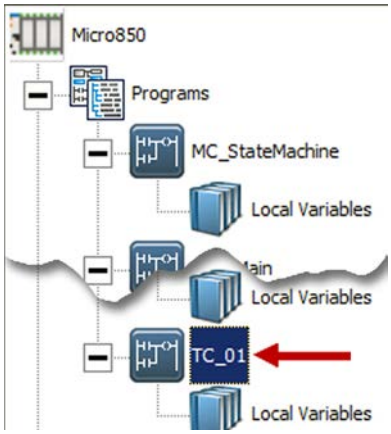
4. From the Channel 0 Output Type pull-down menu, choose the analog output type for your application.
5. From the Channel 0 Output State pull-down menu, choose Enabled.



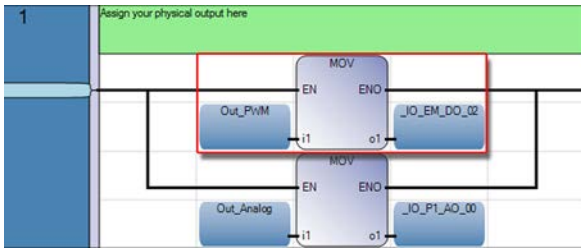


6. In your Project Organizer, double-click TC_01.

ATTENTION: When a project is created with the CCAT generation function, the program name is 'Device name', which you define.



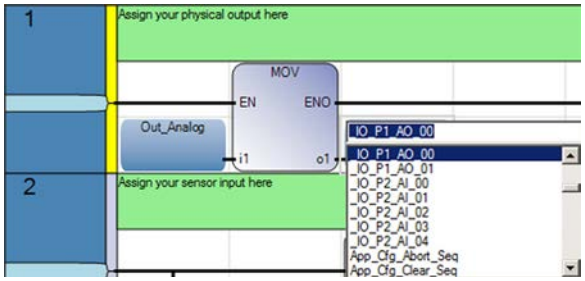
7. In rung 1, delete the MOV instruction for Out_PWM.



8. Determine the analog output to control your heating or cooling device.

In rung 1, either keep the default analog output variable _IO_P1_AO_00 or click the variable to choose another one.

ATTENTION: When a project is created with the CCAT generation function, the terminal selection is blank.
You must select the analog output terminal via the pull-down menu.



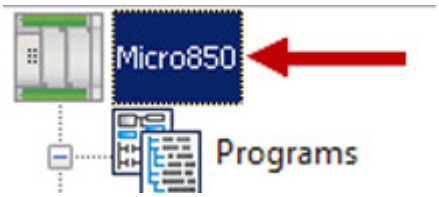
PWM Control Mode

Follow these steps if PWM is your preferred control mode.

IMPORTANT Use a transistor output-type controller if you use PWM Control mode.

1. Start the supplied IPID Temperature Controller Building Block project for your specific Micro800 controller with the Connected Component Workbench software.

   If necessary, use controller type change to match your Micro800 controller catalog number. Refer to the software help for instructions on how to change the controller type.

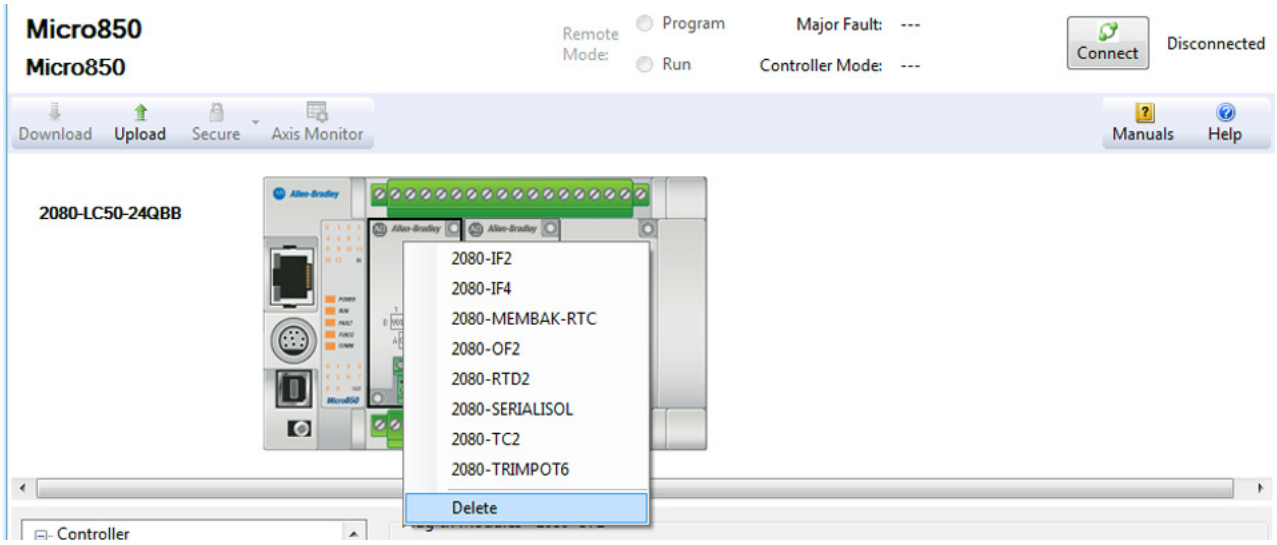


2. In your Project Organizer, double-click the Micro800 controller icon to launch the controller configuration screen.

   The Controller Detail view appears in the main project window.

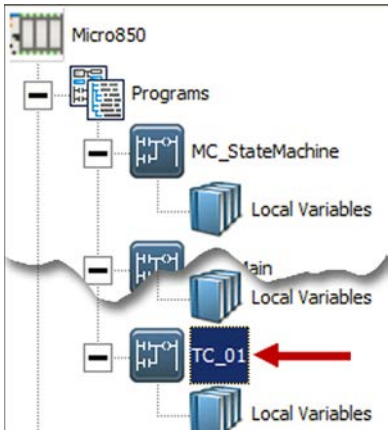
ATTENTION: When a project is created with the CCAT generation function, no plug-in is configured. Therefore, you can skip step 3.

3. Use the following steps to change the default analog output plug-in module (2080-OF2) for slot 1.
   a. Click slot 1.
   b. Right-click slot 1 and choose Delete.

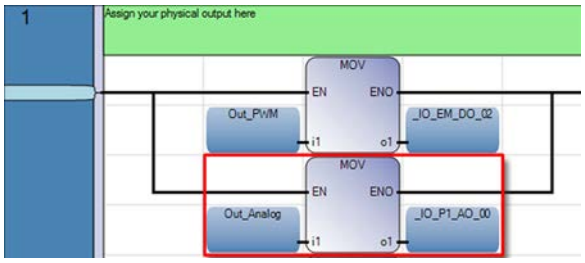


4. In your Project Organizer, double-click TC_01.

ATTENTION: When a project is created with the CCAT generation function, the program name is 'Device name', which you define.



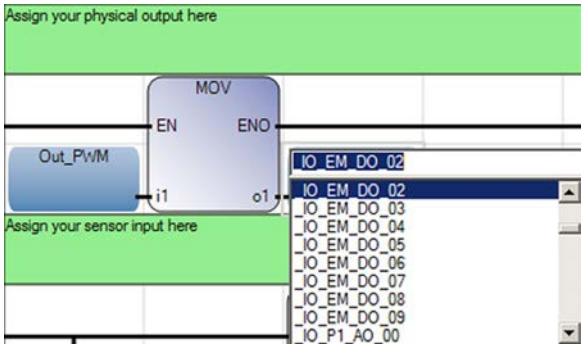
5. In rung 1, delete the MOV instruction for Out_Analog.



6. Determine the digital output for PWM to control your heating or cooling device.

   In rung 1, either keep the default digital output variable _IO_EM_DO_02 or click the variable to choose another one.

ATTENTION: When a project is created with the CCAT generation function, the terminal selection is blank.
You must select the digital output terminal via the pull-down menu.



Select and Configure Your Temperature Sensor

You are expected to have configured your control output from the previous section. Two temperature sensor plug-ins are available for Micro800 controllers, catalog numbers 2080-TC2 and 2080-RTD2. You typically need only one temperature sensor for each control output type and for each temperature sensor plug-in. In this section, you select the type of temperature sensor and plug-in suitable for your application.

2080-TC2 Plug-in

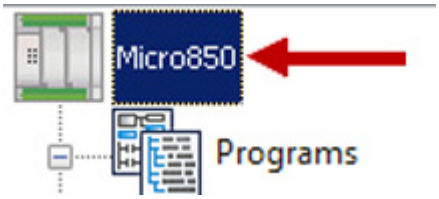
Use the following table as reference if you are using a thermocouple-type temperature sensor.

Table 1 - Thermocouple Sensor Types and Temperature Ranges

Thermocouple Type	Temperature Range °C (°F)		Accuracy °C (°F)		ADC Update Rate in Hz (Accuracy °C)
	Min	Max	±1.0 °C (°F)	±3.0 °C (°F)	
B	40 (104)	1820 (3308)	90…1700 (194…3092)	< 90 (< 194) > 1700 (> 3092)	4.17, 6.25, 10, 16.7 (±1.0) 19.6, 33, 50, 62, 123, 242, 470 (±3.0)
E	-270 (-454)	1000 (1832)	-200…930 (-328…1706)	< -200 (< -328) > 930 (> 1706)	
J	-210 (-346)	1200 (2192)	-130…1100 (-202…2012)	< -130 (< -202) > 1100 (> 2012)	
K	-270 (-454)	1370 (2498)	-200…1300 (-328…2372)	< -200 (< -328) > 1300 (> 2372)	
N	-270 (-454)	1300 (2372)	-200…1200 (-328…2192)	< -200 (< -328) > 1200 (> 2192)	
R	-50 (-58)	1760 (3200)	40…1640 (104…2984)	< 40 (< 104) > 1640 (> 2984)	
S	-50 (-58)	1760 (3200)	40…1640 (104…2984)	< 40 (< 104) > 1640 (> 2984)	
T	-270 (-454)	400 (752)	-220…340 (-364…644)	< -220 (< -364) > 340 (> 644)	

Follow these steps to select a thermocouple-type temperature sensor for your Controller-based Temperature Control Application Building Block project.

1. In your Project Organizer, double-click the Micro800 controller icon to launch the controller configuration screen.

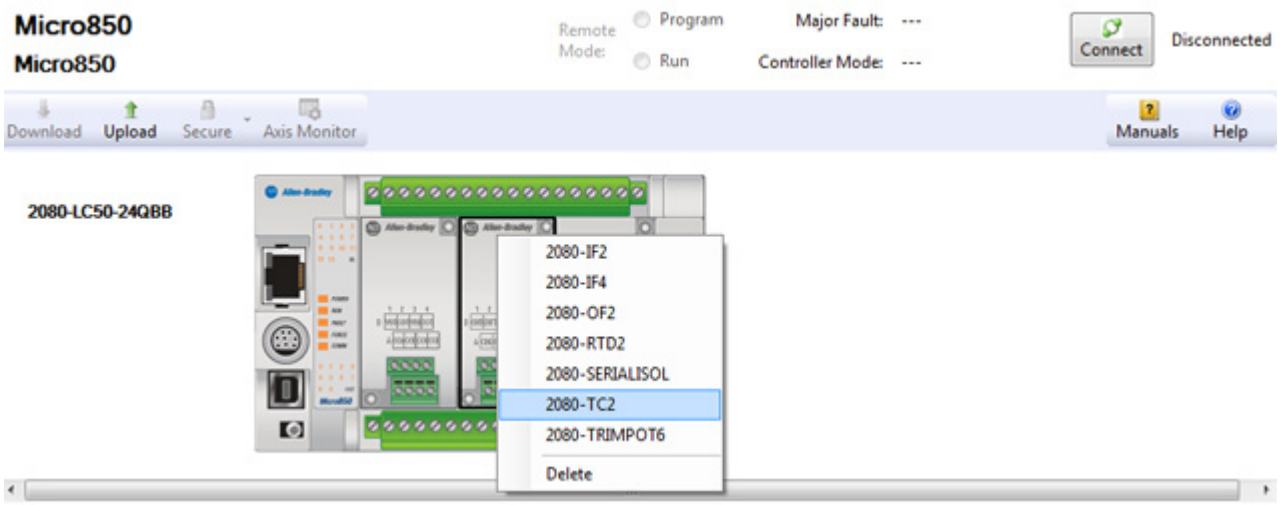


The Controller Detail view appears in the main project window.

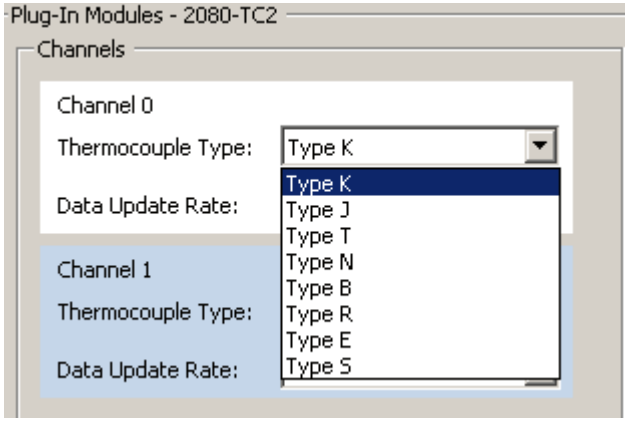
ATTENTION: When a project is created with the CCAT generation function, no plug-in module is configured. You must add and configure the plug-in manually.

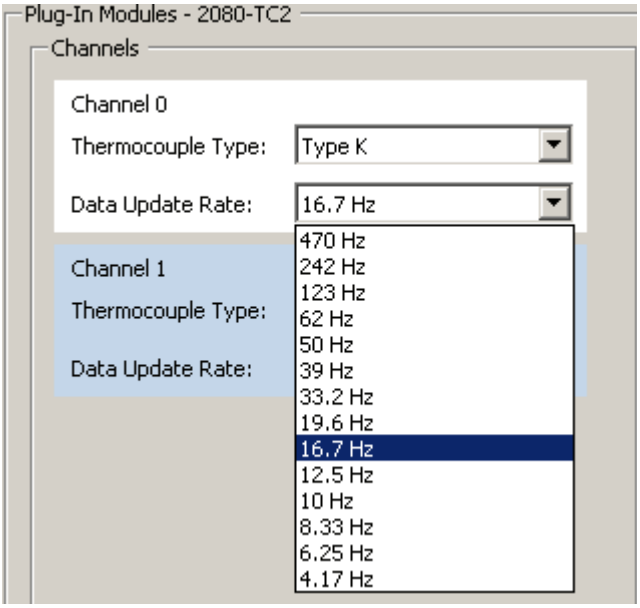
Refer to the default configuration described in the following steps.

2. Use the following steps to change the default plug-in module (2080-RTD2) for slot 2.
   a. Click slot 2.
   b. Right-click slot 2 and choose 2080-TC2.



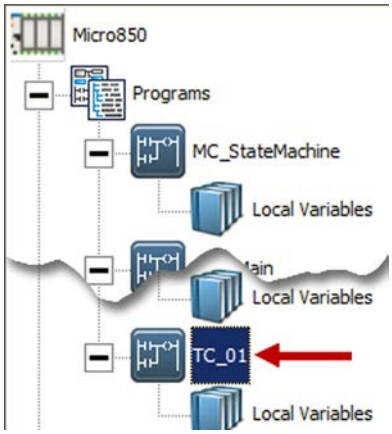
3. From the Channel 0 Thermocouple Type pull-down menu, choose the thermocouple type for your application.
4. From the Channel 0 Data Update Rate pull-down menu, choose the data update rate for your application.





5. In your Project Organizer, double-click TC_01.

ATTENTION: When a project is created with the CCAT generation function, the program name is 'Device name', which you define.



6. In rung 2, either keep the default variables _IO_P2_AI_00 and _IO_P2_AI_02 or click each variable for other choices.

ATTENTION: When a project is created with the CCAT generation function, these terminal selections are blank. You must select the analog input terminals via the pull-down menus.

Each temperature sensor input consists of two analog values, which are temperature feedback and sensor status. These values must be paired so the sensor status properly represents the temperature feedback measurement.

Example:

_IO_P*x*_AI_00 measures the temperature value for input 1 and _IP_P*x*_AI_02 indicates sensor status.

Therefore:

_IO_P*x*_AI_00 must be paired with _IP_P*x*_AI_02 and

_IO_P*x*_AI_01 must be paired with _IP_P*x*_AI_03

Sensor status provides information such as sensor connectivity, and temperature over-range and under-range for their respective temperature feedback.

2080-RTD2 Plug-in

Use the following table as reference if you are using a RTD-type temperature sensor.

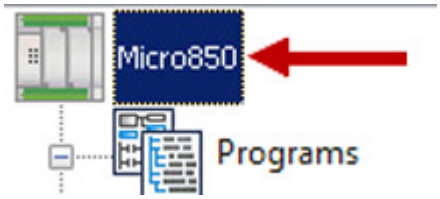
Table 2 - Sensor Types and Temperature Ranges

Sensor Type	Temperature Range °C (°F)		Accuracy °C (°F)		ADC Update Rate in Hz (Accuracy °C)
	Min	Max	±1.0 °C (°F)	±3.0 °C (°F)	
PT100 385	-200 (-328)	660 (1220)	-150…590 (-238…1094)	< -150 (< -238) > 590 (> 1094)	**3-wire others** 4.17, 6.25, 10, 16.7, 19.6, 33, 50 (±1.0) 62, 123, 242, 470 (±3.0) **2- and 3-wire Cu10**[1] 4.17, 6.25, 10, 16.7 (> ±1.0 °C, < ±3.0) 19.6, 33, 50, 62, 123, 242, 470 (> ±3.0) **2-wire others** 4.17, 6.25, 10, 16.7 (±1.0) 19.6, 33, 50, 62, 123, 242, 470 (±3.0)
PT200 385	-200 (-328)	630 (1166)	-150…580 (-238…1076)	< -150 (< -238) > 580 (> 1076)	
PT500 385	-200 (-328)	630 (1166)	-150…580 (-238…1076)	< -150 (< -238) > 580 (> 1076)	
PT1000 385	-200 (-328)	630 (1166)	-150…580 (-238…1076)	< -150 (< -238) > 580 (> 1076)	
PT100 392	-200 (-328)	630 (1166)	-150…580 (-238…1076)	< -150 (< -238) > 580 (> 1076)	
PT200 392	-200 (-328)	630 (1166)	-150…580 (-238…1076)	< -150 (< -238) > 580 (> 1076)	
PT500 392	-50 (-58)	1760 (3200)	40…1640 (104…2984)	< 40 (< 104) > 1640 (> 2984)	
PT1000 392	-50 (-58)	500 (932)	-20…450 (-4…842)	< -20 (< -4) > 450 (> 842)	
Cu10 427[1]	-100 (-148)	260 (500)	[1]	< -70 (< -94) > 220 (> 428)	
Ni120 672	-80 (-112)	260 (500)	-50…220 (-58…428)	< -50 (< -58) > 220 (> 428)	
NiFe604 518	-200 (-328)	200 (392)	-170…170 (-274…338)	< -170 (< -274) > 170 (> 338)	

(1) >±1, <±3 accuracy range applies to a -70…220 °C (-94…428 °F) temperature range. Accuracy is >±3 °C for temperatures above this temperature range.

Follow these steps to select a RTD-type temperature sensor for your Controller-based Temperature Control Application Building Block project.

1. In your Project Organizer, double-click the Micro800 controller icon to launch the controller configuration screen.



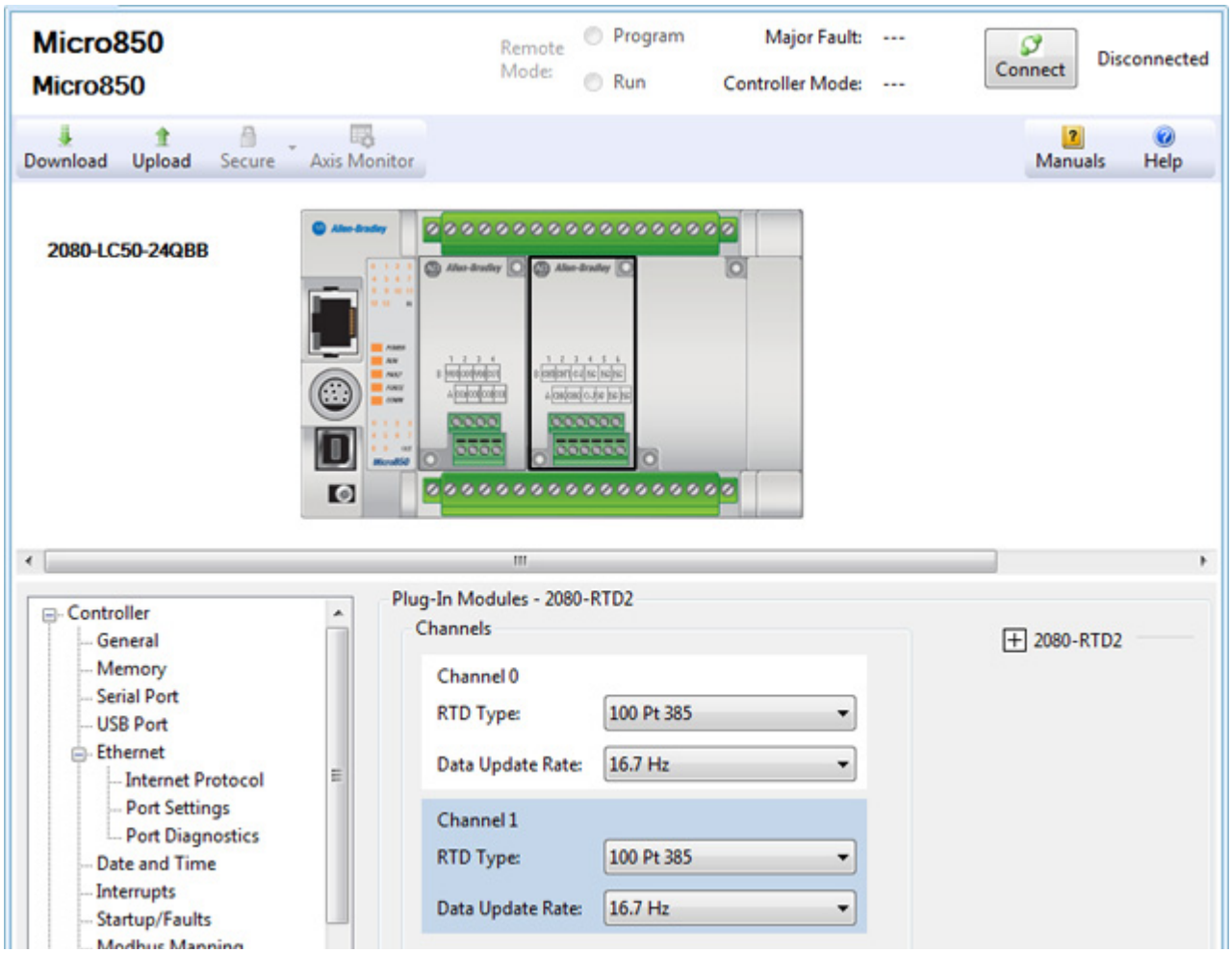
The Controller Detail view appears in the main project window.

ATTENTION: When a project is created with the CCAT generation function, no plug-in module is configured. You must add and configure the plug-in manually.

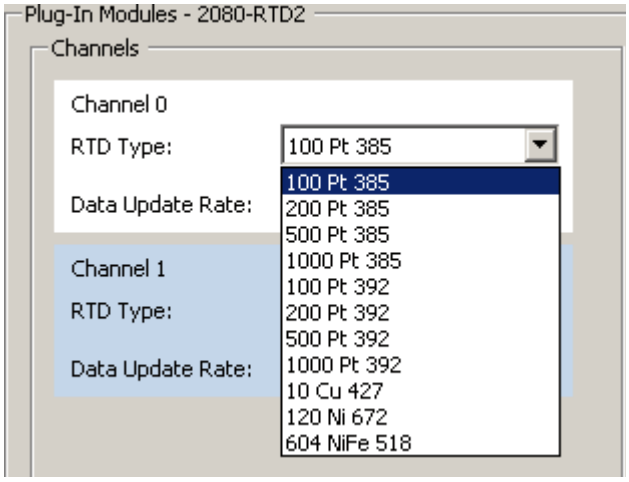
Refer to the default configuration described in the following steps.

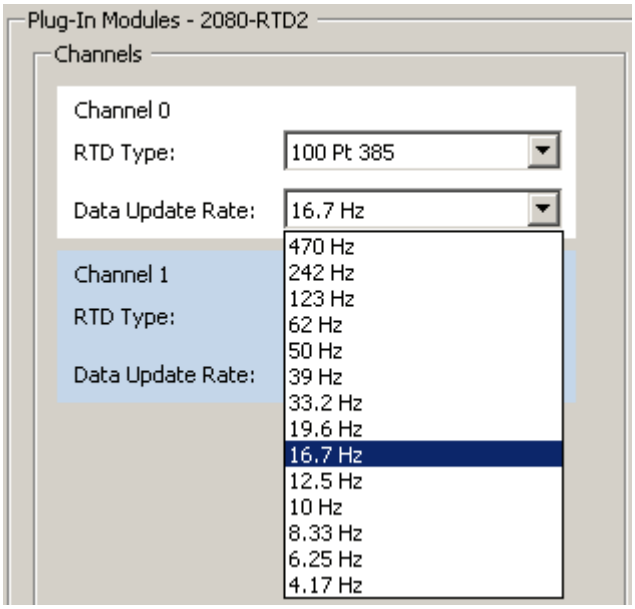
2. Click slot 2.

The default plug-in module (2080-RTD2) for slot 2 does not need to be changed.



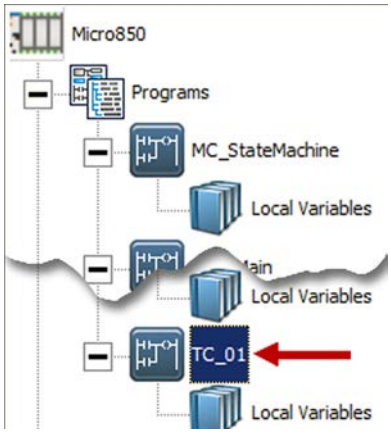
3. From the Channel 0 RTD Type pull-down menu, choose the RTD type for your application.
4. From the Channel 0 Data Update Rate pull-down menu, choose the data update rate for your application.





5. In your Project Organizer, double-click TC_01.

ATTENTION: When a project is created with the CCAT generation function, the program name is 'Device name', which you define.



6. In rung 2, _IO_P2_AI_00 and _IO_P2_AI_02 are the default variables for the feedback temperature value and sensor status to the temperature control function block.

   Keep the default settings or click each variable for other choices.

> **ATTENTION:** When a project is created with the CCAT generation function, these terminal selections are blank. You must select the analog input terminals via the pull-down menus.

Each temperature sensor input consists of two analog values, which are temperature feedback and sensor status. These values must be paired so the sensor status properly represents the temperature feedback measurement.

Example:

_IO_P*x*_AI_00 measures the temperature value for input 1 and _IP_P*x*_AI_02 indicates sensor status.

Therefore:

_IO_P*x*_AI_00 must be paired with _IP_P*x*_AI_02 and

_IO_P*x*_AI_01 must be paired with _IP_P*x*_AI_03

Sensor status provides information such as sensor connectivity, and temperature over-range and under-range for their respective temperature feedback.

Wire Your Temperature Control System

This section shows how to wire both controller output modes and both temperature sensors.

Figure 1 - Analog Output Wiring

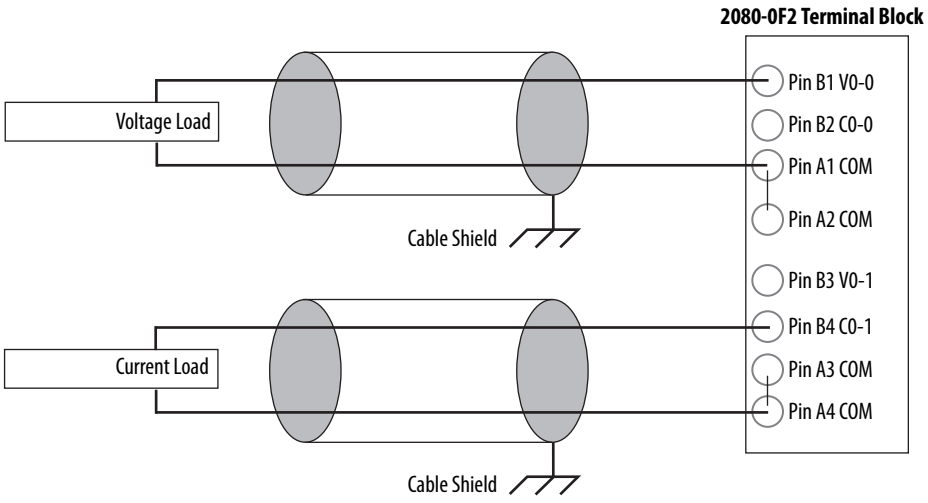
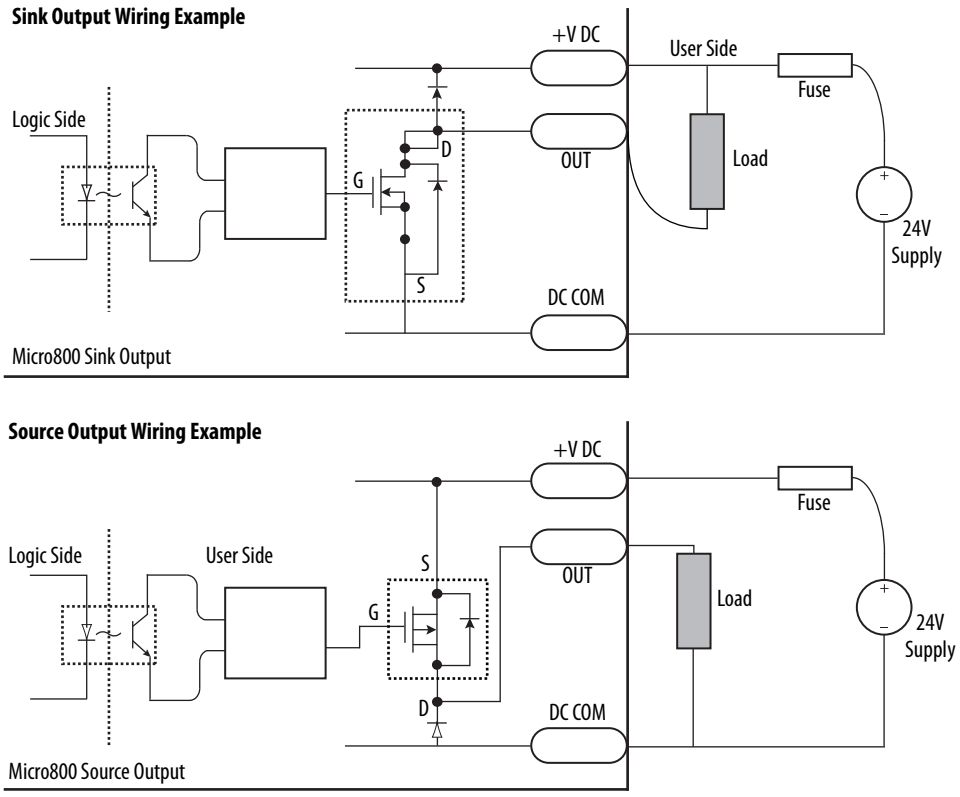


Figure 2 - PWM Output Wiring



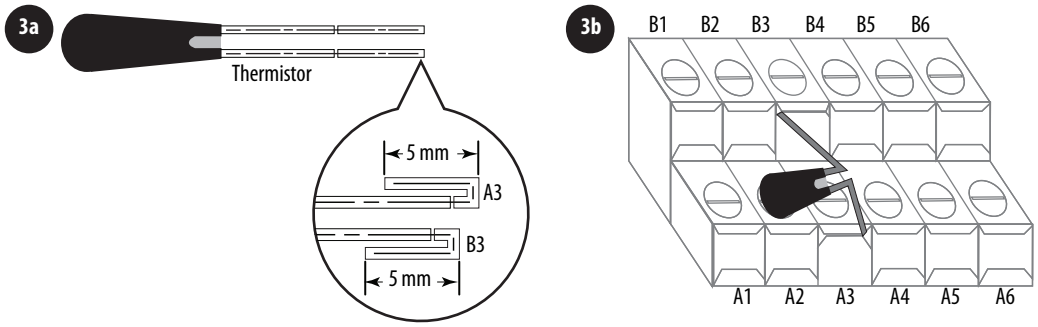
Wiring Diagram for 2080-TC2 Thermocouple

The 2080-TC2 thermocouple requires a cold junction compensation (CJC) sensor to function. This sensor is a non-polarized, passive negative temperature co-efficient thermistor (EPCOS B57869S0502F140). It is readily available through most third-party vendors. For further information, refer to the Micro800 Plug-in Modules User Manual, publication 2080-UM004.

Follow these steps to connect the CJC sensor.

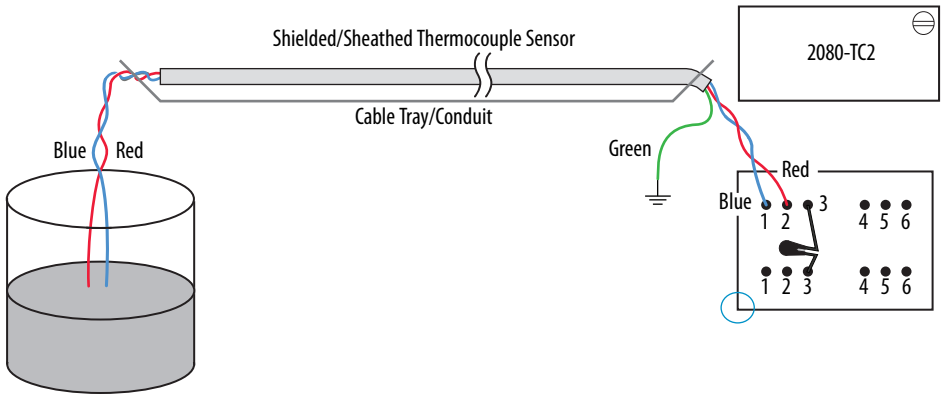
1. Connect the thermocouples to channels 0 and 1.
2. Connect and screw the thermistor to terminals A3 and B3 (see 3a in Figure 3).
3. Once fitted, bend the black bead of the thermistor so it makes a secure contact with the screw head of terminal A2 (see 3b in Figure 3).

Figure 3 - Wiring a CJC Sensor on a 2080-TC2 Thermocouple



4. With the CJC sensor connected, connect the thermocouple wires directly to the terminal block.

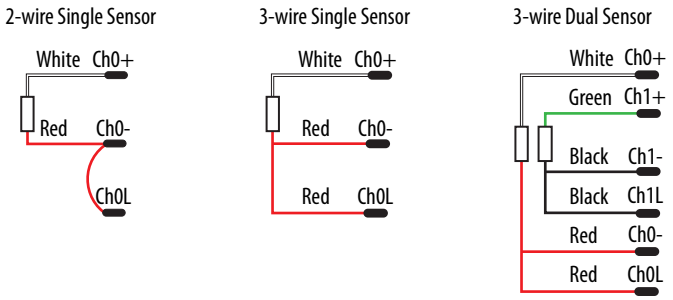
Figure 4 - 2080-TC2 Direct Sensor Wiring



Wiring Diagram for 2080-RTD Thermocouple

A 2080-RTD thermocouple does not require a CJC sensor. You can connect its wires directly to the input terminal. For further information, refer to For further information, refer to the Micro800 Plug-in Modules User Manual, publication 2080-UM004.

Figure 5 - 2080-RTD Sensor Wiring



IMPORTANT The illustration shows channel 0 only for 2-wire and 3-wire single sensor connections. The wire colors illustrate a specific RTD sensor type available in the market.

Notes:

Validate Your System

This chapter provides instructions on how to configure, connect, and validate communication between the devices in your Controller-based Temperature Control Application Building Block.

Before You Begin

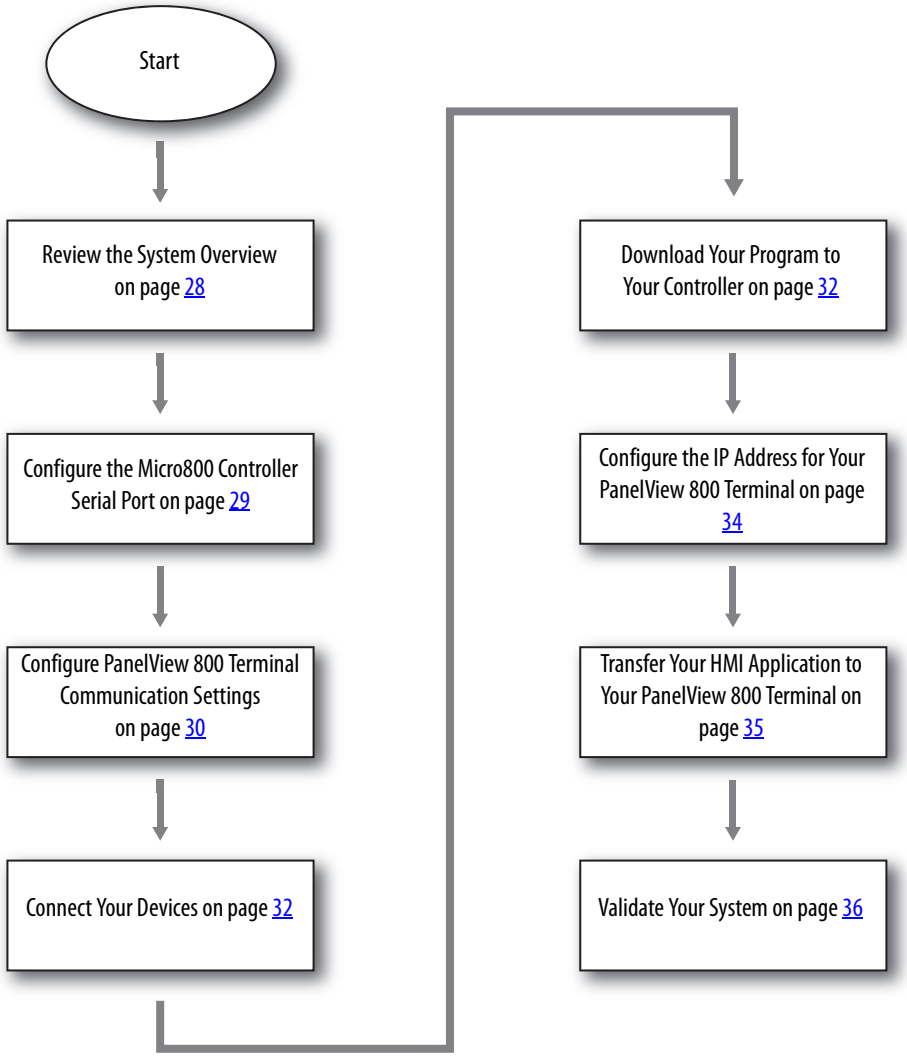
- Complete the steps in Chapter 1.
- Verify that the devices are connected as shown in the assembled wiring diagrams.
- Verify that the Micro800 controller and the PanelView 800 terminal have power applied to them.

What You Need

- Windows-based personal computer with Internet access
- Connected Components Workbench software, version 6 or later
- Micro800 controller (PWM Control mode requires transistor outputs)
- 4-inch (or larger) PanelView 800 terminal
- 1761-CBL-PM02, 9-pin to 8-pin MINI-DIN RS-232 communication cable
- Supported temperature sensor
- Heating or cooling device
- Thermocouple or RTD plug-ins
- Analog output plug-ins (for analog control)
- USB programming cable (A to B) for personal computer to Micro800 communication
- Ethernet cable to transfer the PanelView 800 application

Follow These Steps

Follow these steps to configure your product selection.

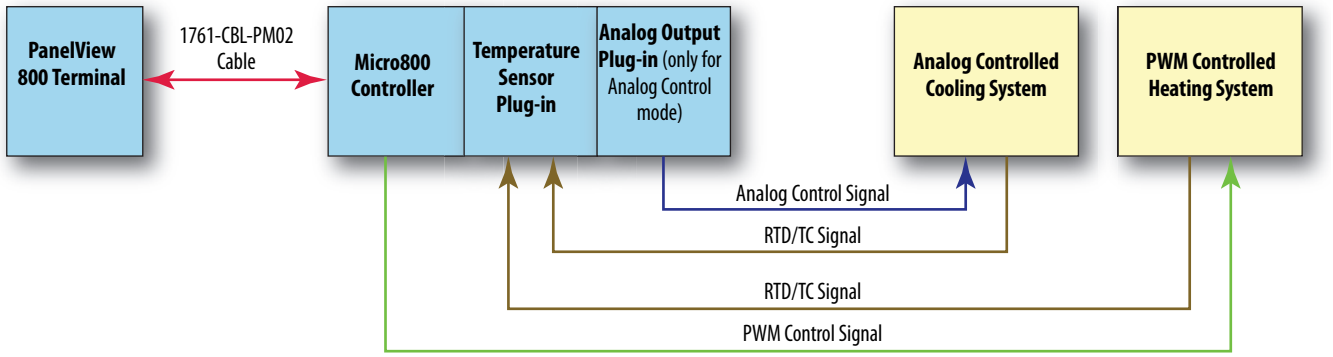

Start
Review the System Overview on page 28
Configure the Micro800 Controller Serial Port on page 29
Configure PanelView 800 Terminal Communication Settings on page 30
Connect Your Devices on page 32
Download Your Program to Your Controller on page 32
Configure the IP Address for Your PanelView 800 Terminal on page 34
Transfer Your HMI Application to Your PanelView 800 Terminal on page 35
Validate Your System on page 36

Review the System Overview

The following figure illustrates a sample device layout with two Controller-based Temperature Control Application Building Blocks for a heating and cooling system. The PanelView 800 terminal and Micro800 controller are configured as CIP serial devices, connected by and communicating through a serial port cable. There are two control outputs (a PWM and an analog control signal) and two RTD/TC input signals, each for the heating and cooling systems.

You can add more temperature control systems with additional temperature sensor plug-in and optional analog output plug-in for Analog Control mode or digital output for PWM Control.

Figure 6 - Sample Device Layout



Configure the Micro800 Controller Serial Port

The following table lists the default settings for the serial port of the Micro800 controller in the supplied Controller-based Temperature Control Application Building Block project.

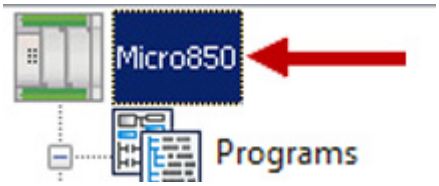
Table 3 - Default Serial Port Settings

Parameter	Default Setting
Driver	CIP serial
Communication Rate	38400
Parity	None
Station address	1

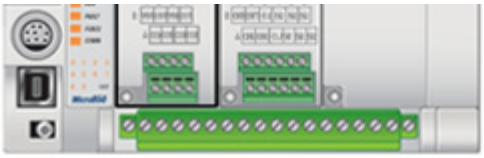
Level	Parameter	Default Setting
Advanced	DF1 mode	DF1 full-duplex
	Control line	No handshake
	Error detection	CRC
	Embedded responses	"After One Received"
	Duplicate packet detection	TRUE
	ACK time-out (x20ms)	50
	NAK retries	3
	ENQ retries	3
	Transmit retries	3
	RTS off-delay	0
	RTS send-delay	0

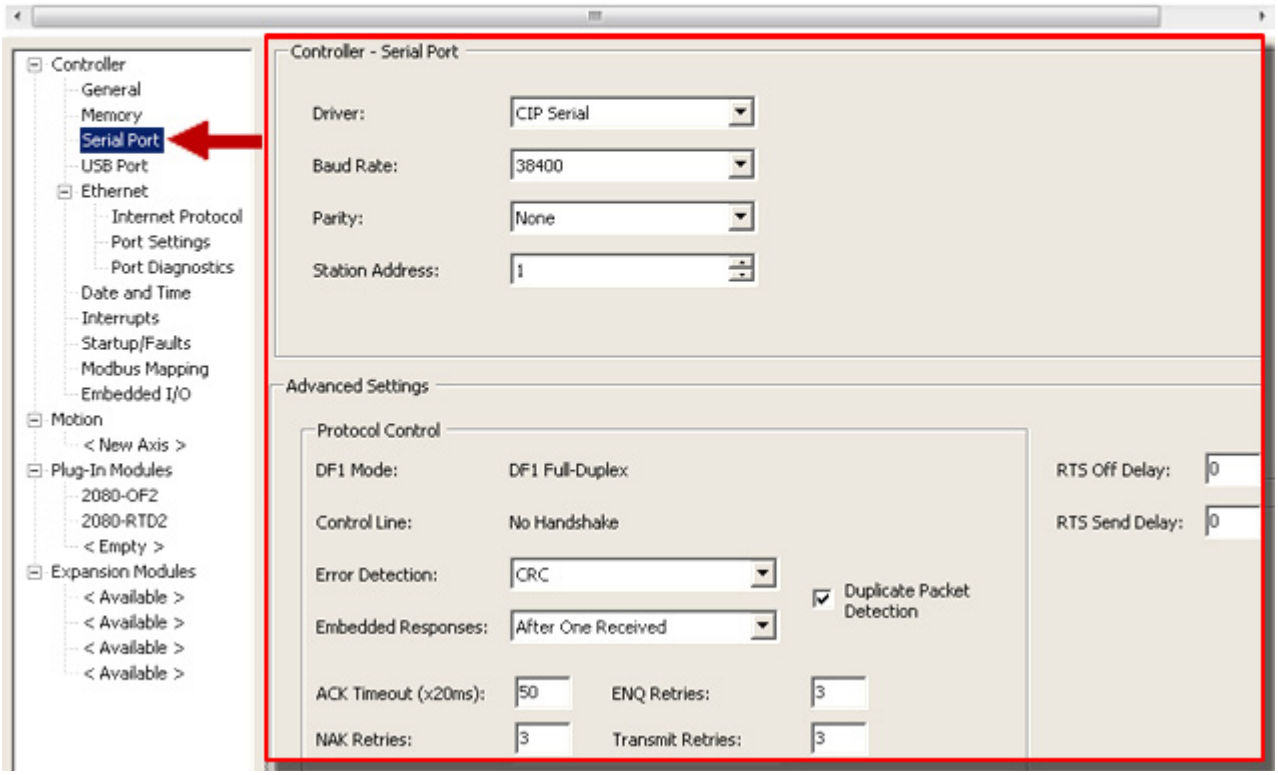
Follow these steps to verify the default settings for the Micro800 controller serial port in your Connected Components Workbench project that you began modifying in Chapter 1.

1. In your Project Organizer, double-click the Micro800 controller icon to launch the controller configuration screen.



2. In the controller configuration list, click Serial Port to display the serial port settings.





3. Change any default settings as needed for your application.

Configure PanelView 800 Terminal Communication Settings

The following table lists the default communication settings for the PanelView 800 terminal in the supplied Controller-based Temperature Control Application Building Block project.

Table 4 - Default Communication Settings

	Parameter	Default Setting
Component	Protocol	CIP serial
	Port	RS-232
	Communication Rate	38400
	Parity	None
	Flow control	None

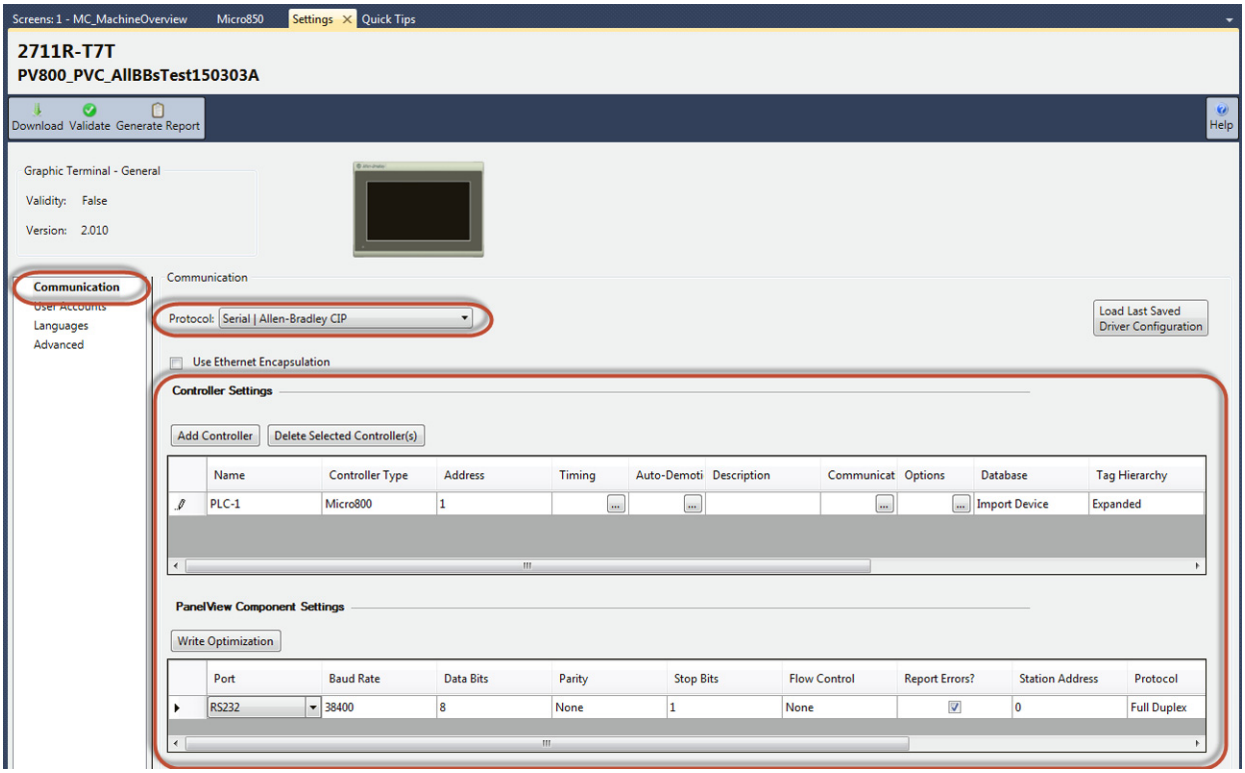
	Parameter	Default Setting
Controller	Name	PLC-1
	Controller type	Micro800
	Address	1

Follow these steps to modify these settings in the default Connected Components Workbench project.

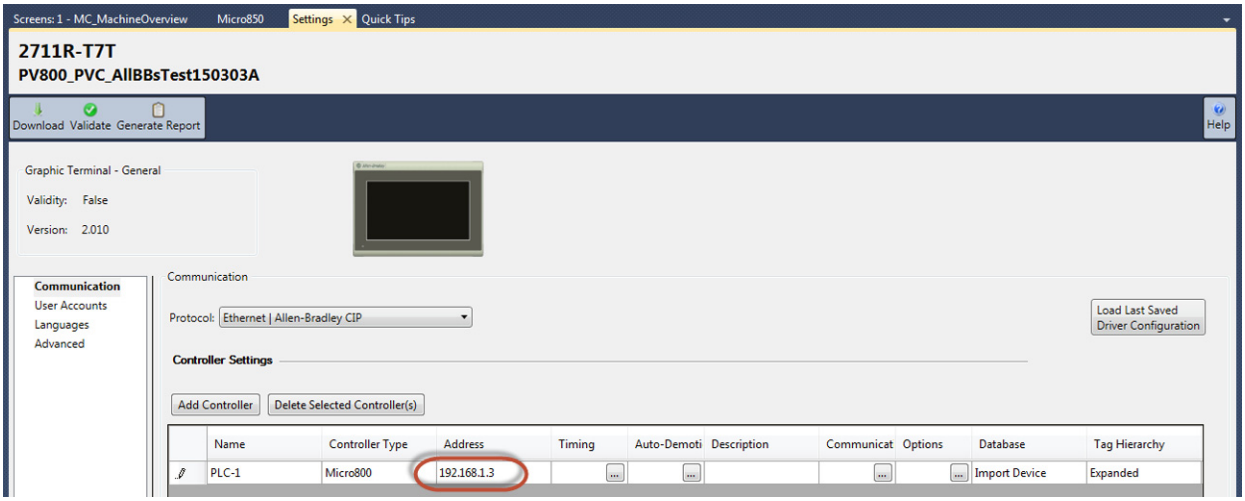
1. In your Project Organizer, double-click the PanelView 800 device icon to open the PanelView 800 application editor.

   The PanelView 800 Communication Settings pane appears in the main project window.

2. Configure the appropriate communication settings:
   - For CIP Serial communication, configure the settings shown below.



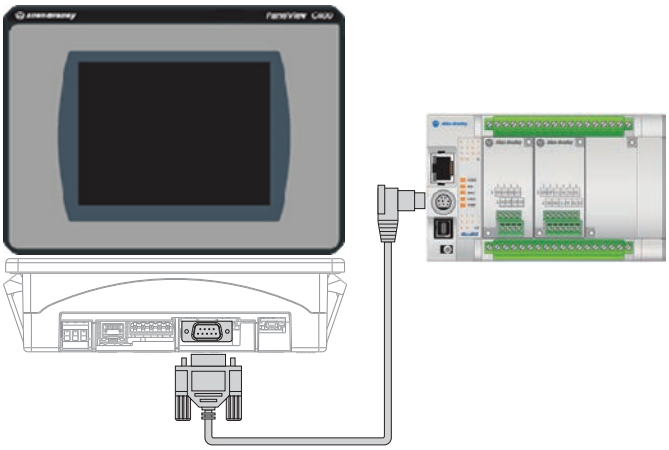
   - For CIP on Ethernet communication, configure the settings shown below.



Connect Your Devices

Follow these steps to connect your devices.

1. Connect the PanelView 800 terminal to the Micro800 controller:
   - If a CIP serial connection is used, connect the PanelView 800 terminal serial RS-232 port to your Micro800 controller's embedded serial port by using a 1761-CBL-PM02 cable.



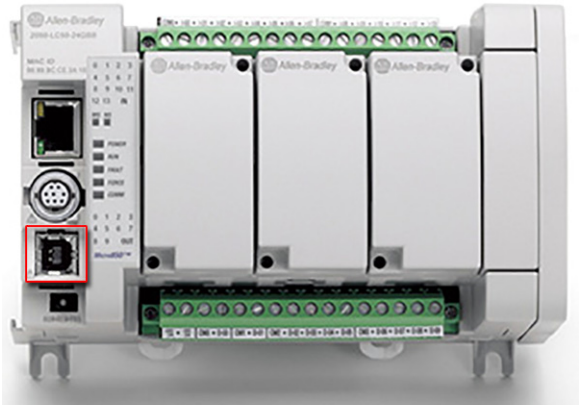
   - If a CIP on Ethernet connection is used, connect the PanelView 800 terminal Ethernet port to the Stratix™ switch and connect another Ethernet cable from the Stratix switch port to the Micro800 controller's embedded Ethernet port.

Download Your Program to Your Controller

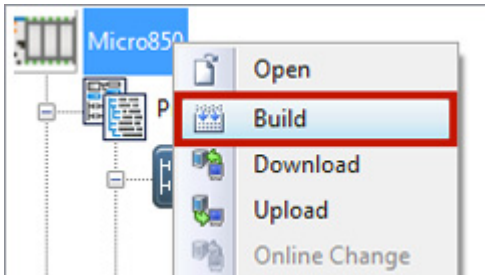
Follow these steps to build and download your program to your Micro800 controller.

1. Use a USB A-to-B cable to connect your personal computer to the USB port on your Micro800 controller.

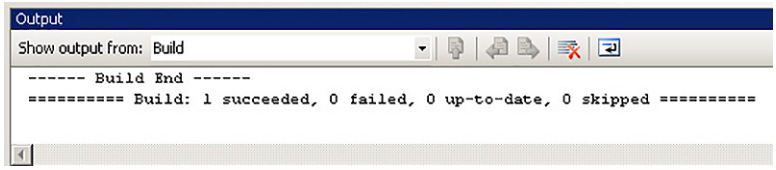
   If you are prompted to install any drivers, use the recommended drivers.



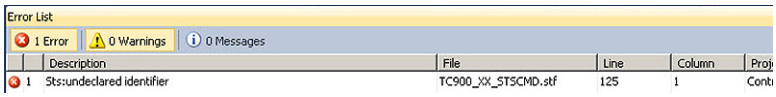
2. In your Project Organizer, right-click your controller icon and choose Build.



3. If the build is successful, the Output pane at the bottom of your project window displays a success message.

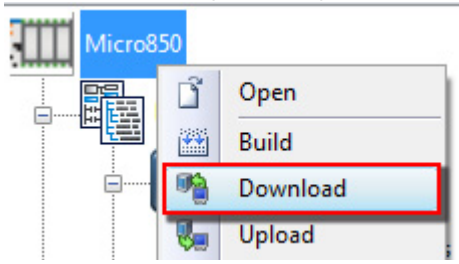


If the build is unsuccessful, an error list appears.

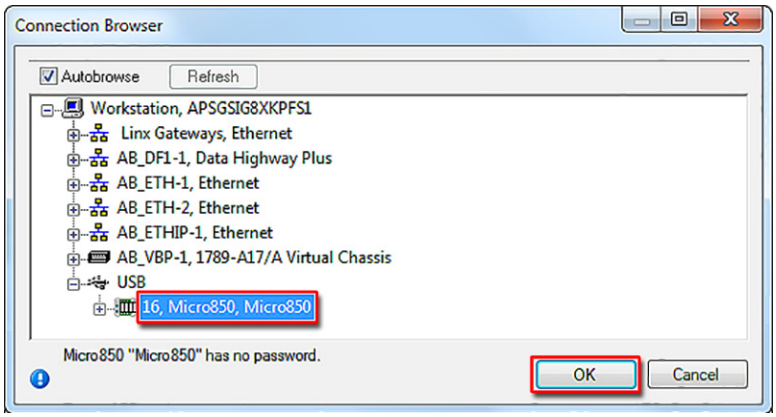


a. If the build is successful, proceed to step 4.
b. Double-click an error description to take you to that error.
c. Correct each error.
d. Repeat step 2 through step 3c until the build is successful, and continue to step 4.

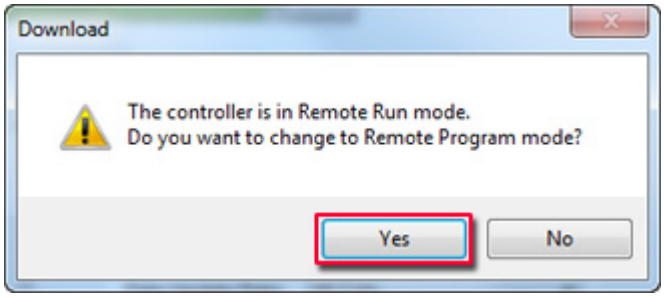
4. In your Project Organizer, right-click the Micro800 controller icon and choose Download.



5. Select your controller in the Connection Browser and click OK.

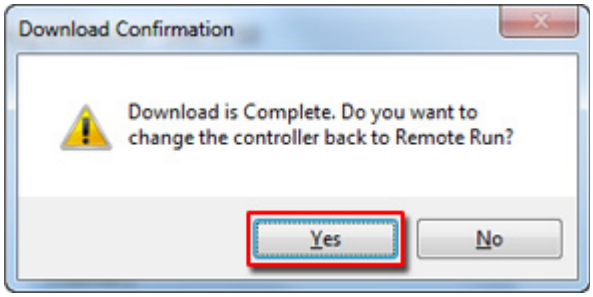


6. If prompted to change the controller mode to Remote Program, click Yes.



When the download is completed, the software prompts you to change the controller mode to Remote Run.

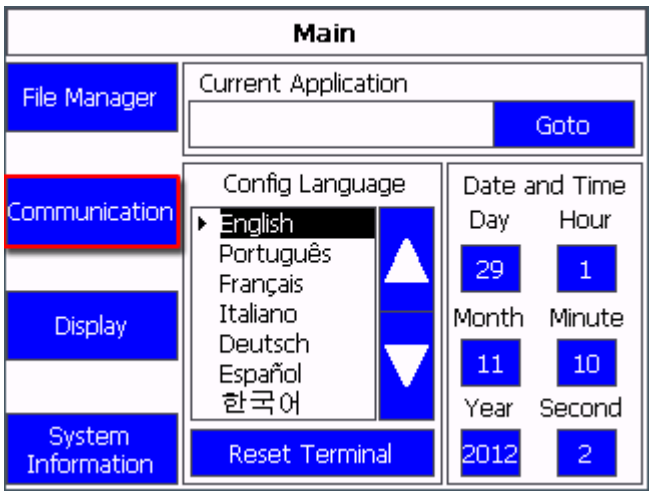
7. Click Yes.



Configure the IP Address for Your PanelView 800 Terminal

Follow these steps to configure a static IP address on the PanelView 800 terminal.

1. From the Main menu, press Communication to open the Communication screen.

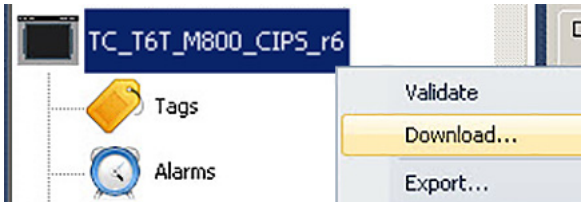


2. Press Set Static IP Address.
3. Configure the IP Address and Mask values so they are in the same range as your personal computer.
4. Press Main to return to the Main menu.

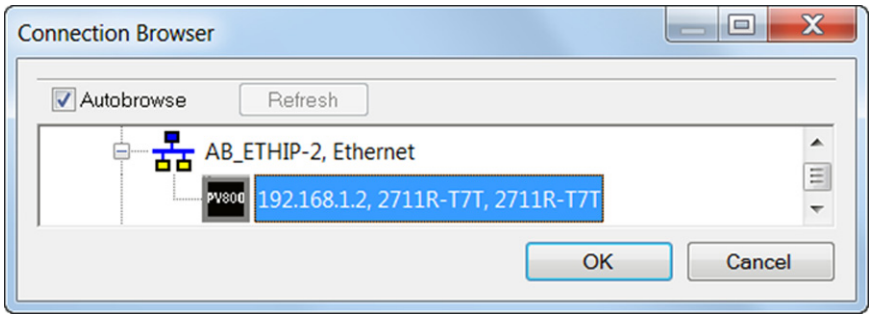
Transfer Your HMI Application to Your PanelView 800 Terminal

Follow these steps to transfer your HMI application to the PanelView 800 terminal by using Connected Components Workbench software.

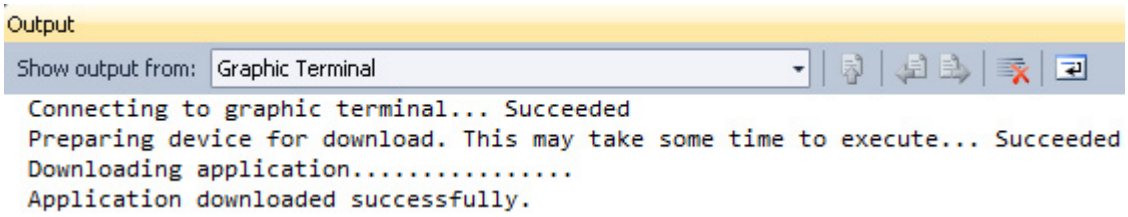
1. In your Project Organizer, right-click the PanelView 800 device icon and choose Download.



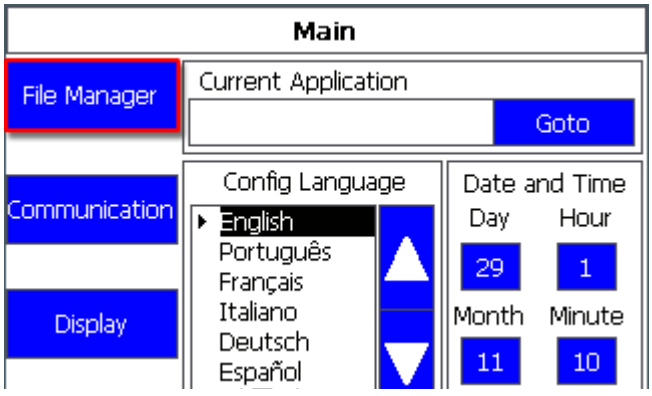
2. In the Connection Browser window, select the PanelView 800 terminal as your download destination.



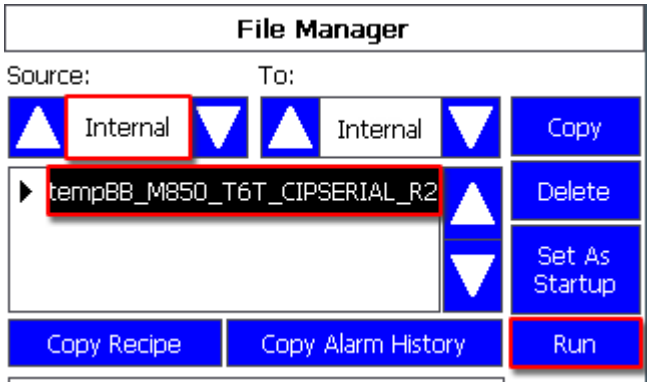
3. Click OK.
4. Verify that the download completed successfully.


Output
Show output from: Graphic Terminal
Connecting to graphic terminal... Succeeded
Preparing device for download. This may take some time to execute... Succeeded
Downloading application.....
Application downloaded successfully.

5. From the Main menu of your PanelView 800 terminal, press File Manager.



6. On the File Manager screen, select Internal as your Source.
7. Select your application.
8. Press Run.



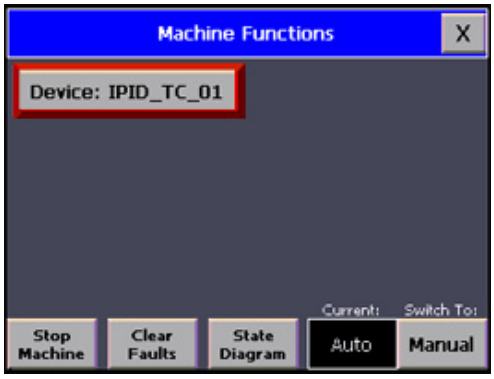
Validate Your System

In this section, you review the Machine Function screen and explore the HMI application screens to test the manual control of the Temperature Control Building Block.

Understand the Machine Functions Screen

The Machine Functions screen is the screen that links to all installed building blocks. When this screen is first loaded, you can complete the following tasks:

- Return to the machine Overview screen by pressing the 'X' in the upper right corner of the screen.
- View a device in detail by pressing its button.
- View the current machine Auto/Manual state.
- Change the current machine Auto/Manual state.
- Clear machine faults, start or stop the machine (while in Auto mode), and go to the machine State Diagram Overview screen.



The border of the device button changes color to indicate a specific status. For the temperature controller, the button border colors indicate the following status:

- A green border indicates the temperature controller has the communication write command enabled.
- A Gray border indicates the temperature controller is inactive.
- A red border indicates the temperature controller has a fault or an alarm present.

Main Control Screen

Follow this procedure to access and understand the main control features.

1. On the Machine Function screen, switch the Operation mode to Manual.

IMPORTANT	If the Main Control screen is accessed while the program is in the Auto Operation mode, then some of the commands are inactive and some of the input selectors are unavailable.

2. Press Device: IPID_TC_01.

   The Main Control screen for that device appears in Manual mode and resembles the following example.

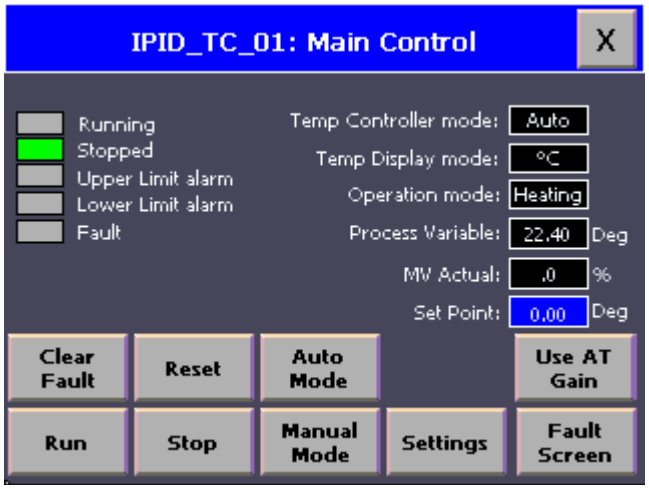


Table 5 - Main Control Status Indicators

Status	Gray	Green	Red
Running	The temperature controller is not running.	The temperature controller is running.	—
Stopped	The temperature controller is not stopped.	The temperature controller is stopped.	—
Upper limit alarm	The temperature is below the upper limit level.	The temperature exceeds the upper limit level.	—
Lower limit alarm	The temperature is above the lower limit level.	The temperature is below the lower limit level.	—
Fault	No other controller alarms or faults.	—	Controller error or other fault is present.

Table 6 - Main Control Status Data Fields

Status	Description
Temp Controller mode	Operating mode of controller (Auto: MV control by PID loop/Man: Manual MV control).
Temp Display mode	Unit of measurement for displayed temperature (Celsius or Fahrenheit).
Operation mode	Operating mode being monitored (cooling or heating).
Process variable	Temperature that is controlled or measured.
MV (manipulated variable) actual	Current MV value.
Set point	Data field where temperature set point is entered. **IMPORTANT:** This data field is visible only when the temperature controller is in Manual mode.

Table 7 - Main Control Command Buttons

Status	Description
Clear fault	Press to clear any fault.
Reset	Press to initialize the MV.
Run	Press to begin temperature control.
Stop	Press to stop temperature control.
Auto mode	Press to place temperature control in Auto mode.
Manual mode	Press to place temperature control in Manual mode.
Settings	Press to access Temp Control Settings screen.
Use AT Gain	Press to activate Auto-tuned gain parameters. **IMPORTANT:** This button is visible only when the temperature controller is in Auto mode.
Fault screen	Press to access the Fault screen.
X	Press to exit the Main Control screen and return to the previous screen.

Settings Screen

The Settings screen is accessed by pressing the Settings button on the Main Control screen and resembles the following example.

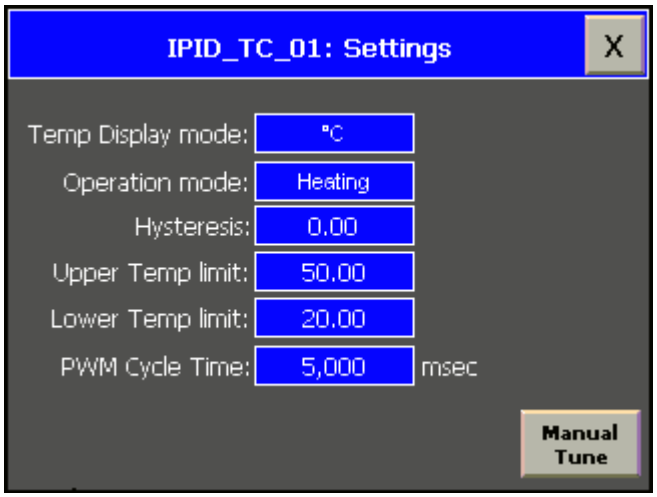


Table 8 - Settings Status Data Fields

Status	Description
Temp Display mode	Set the unit of measurement for displayed temperature (Celsius or Fahrenheit).
Operation mode	Set the operating mode being monitored (cooling or heating).
Hysteresis	Set the hysteresis value for control operation. **IMPORTANT:** This is an optional setting. If not required, set to 0.
Upper temp limit	Set the value that triggers the upper limit alarm if it is exceeded.
Lower temp limit	Set the value that triggers the lower limit alarm if it is exceeded.
PWM cycle time	Set the time (in milliseconds) for a signal ON/OFF cycle.

Table 9 - Settings Command Buttons

Status	Description
Auto tune	Press to access the Auto Tune screen. **IMPORTANT:** This button is visible only when the temperature controller is in Manual mode.
Manual tune	Press to access the Manual Tune screen. **IMPORTANT:** This button is visible only when the temperature controller is in Auto mode.
X	Press to exit the Settings screen and return to the previous screen.

Manual Tune Screen

The Manual Tune screen is accessed by pressing the Manual Tune button on the Settings screen and resembles the following example.

TIP This screen is available only when the temperature controller is in Auto mode.

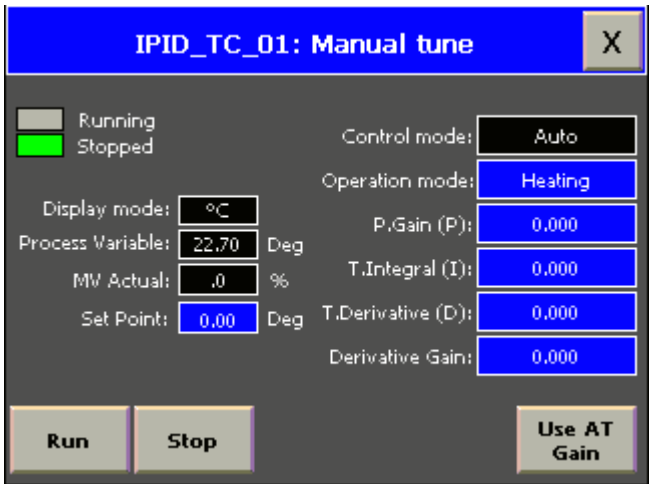


Table 10 - Manual Tune Status Indicators

Status	Gray	Green	Red
Running	The temperature controller is not running.	The temperature controller is running.	—
Stopped	The temperature controller is not stopped.	The temperature controller is stopped.	—

Table 11 - Manual Tune Status Data Fields

Status	Description
Display mode	Set the unit of measurement for displayed temperature (Celsius or Fahrenheit).
Process variable	The temperature that is controlled or measured.
MV actual	Set the current MV value.
Set point	Enter the set point for the temperature controller.
Control mode	Set the operating control mode (Auto: MV control by PID loop/Man: Manual MV control).
Operation mode	Set the operating mode being monitored (cooling or heating).
P.Gain (P)	Set the proportional gain value.
T.Integral (T)	Set the time integral value.
T.Derivative (D)	Set the time derivative value.
Derivative gain	Set the derivative gain value.

Table 12 - Manual Tune Command Buttons

Status	Description
Run	Press to begin temperature control.
Stop	Press to stop temperature control.
Use AT gain	Press to transfer the Auto-tuned gain value to Proportional Gain (P), Time Integral (I), Time Derivative (D) and Derivative Gain.
X	Press to exit the Manual Tune screen and return to the previous screen.

Auto Tune Screen

The Auto Tune screen is accessed by pressing the Auto Tune button on the Settings screen and resembles the following example.

TIP This screen is available only when the temperature controller is in Manual mode.

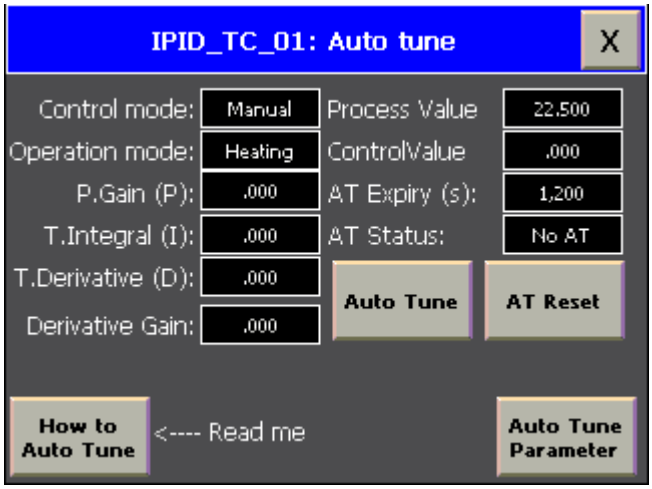


Table 13 - Auto Tune Status Data Fields

Status	Description
Control mode	Set the operating control mode (Auto: MV control by PID loop/Man: Manual MV control).
Operation mode	Set the operating mode being monitored (cooling or heating).
P.Gain (P)	Set the proportional gain value.
T.Integral (T)	Set the time integral value.
T.Derivative (D)	Set the time derivative value.
Derivative gain	Set the derivative gain value.
Process value	Displays the temperature value.
Control value	Displays the control value.
AT expiry (s)	Displays the time left for the Auto Tune process (in seconds) before it fails.
AT status	Displays the Auto Tune status.

Table 14 - Auto Tune Command Buttons

Status	Description
Auto tune	Press to activate the Auto Tune process.
AT reset	Press to reset the Auto Tune process.
How to auto tune	Press to access the note describing how to Auto Tune.
Auto tune parameter	Press to access the AT Parameters screen and set the Auto Tune parameter.
X	Press to exit the Auto Tune screen and return to the previous screen.

AT (Auto Tune) Parameters Screen

The AT Parameters screen is accessed by pressing the AT Parameter button on the Auto Tune screen and resembles the following example.

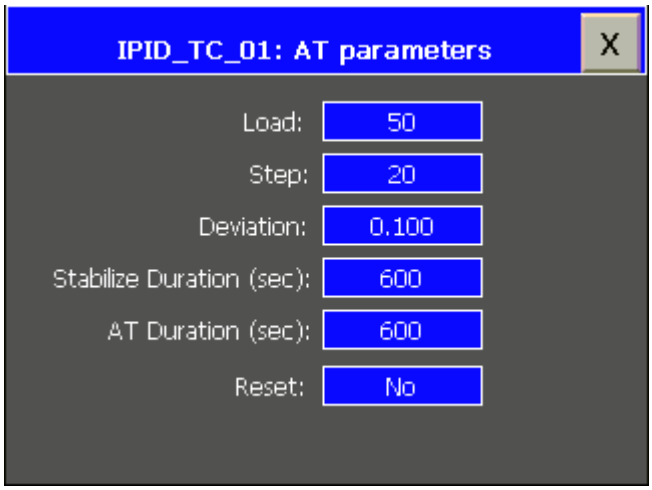


Table 15 - AT Parameters Status Data Fields

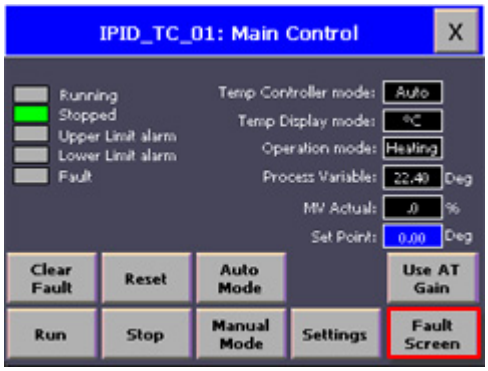
Status	Description
Load	Set the load value for Auto Tune.
Step	Set the step value for Auto Tune.
Deviation	Set the deviation value for Auto Tune.
Stabilize duration (sec)	Set the expected time for the process to stabilize before executing Auto Tune.
AT duration (sec)	Set the waiting time (in seconds) before abandoning Auto Tune.
Reset	Indicates if the output value is reset to zero after an Auto Tune sequence: YES: Resets output value to zero. NO: Leaves output at Load value.

Table 16 - Auto Tune Command Buttons

Status	Description
X	Press to exit the AT Parameters screen and return to the previous screen.

Fault Screen

The Fault screen is accessed by pressing the Fault button on the Main Control screen and resembles the following example.



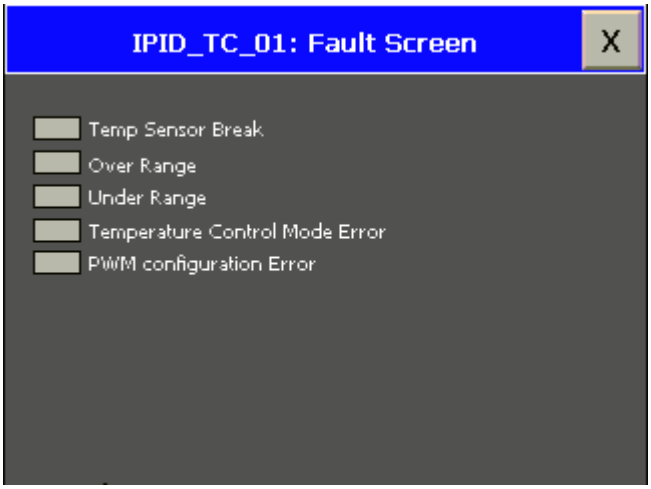


Table 17 - Fault Status Indicators

Status	Gray	Red
Temp sensor break	The temperature sensor wire break is not detected.	The temperature sensor wire break is detected.
Over range	The temperature has not exceeded the upper sensing range.	The temperature has exceeded the upper sensing range.
Under range	The temperature is above the lower sensing range.	The temperature is below the lower sensing range.
Temperature Control mode error	The Temperature Control mode is correct.	A Temperature Control mode error is detected.
PWM configuration error	PWM cycle time is within the configured range.	PWM cycle time is beyond the configured range.

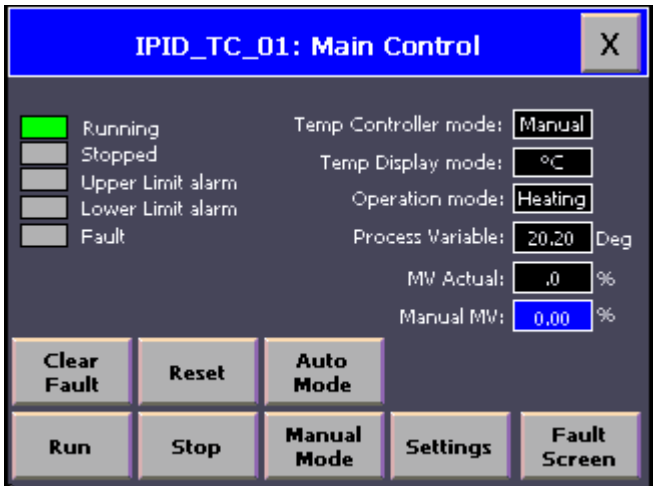
Table 18 - Fault Command Buttons

Status	Description
X	Press to exit the Fault screen and return to the previous screen.

Test the Manual Control Mode

Follow these steps to verify that the Manual control mode works properly.

1. On the Main Control screen, press Manual Mode.
2. Verify that the 'Temp Controller mode' data field changes to 'Manual,' and a 'Manual MV' input box appears.



3. Press the 'Manual MV' input box to enter a new control value in percentage.

   'MV actual' shows an approximate value of the new control value that you entered.

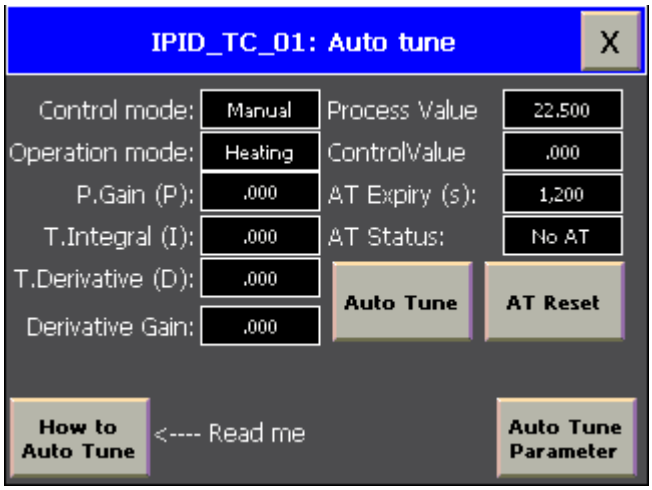
IMPORTANT	Based on the new control value, the discrete output can switch ON and OFF or the analog output can change, which indicates that the building block is configured properly and is working properly.

4. Set the control value to 0, which stops any control action.

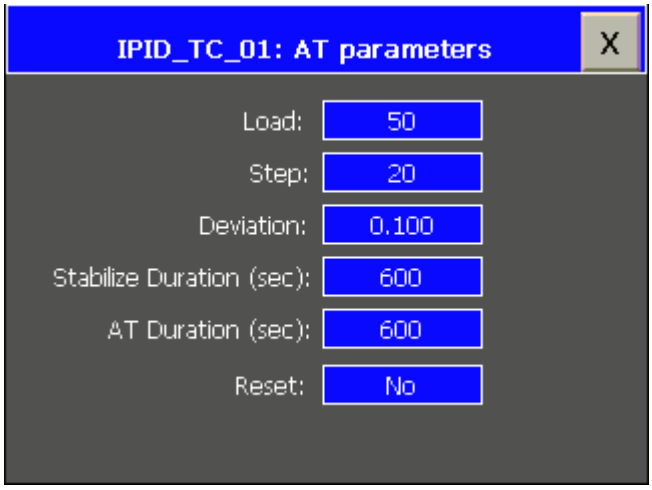
Test the Auto Tune Mode

Follow these steps to verify that the Auto Tune process generates PID parameters.

1. On the Auto Tune screen, verify that all PID parameters are at zero (.000).



2. Press the Auto Tune Parameter button to access the AT Parameters screen.
3. Set up the Auto Tune parameters for your application.



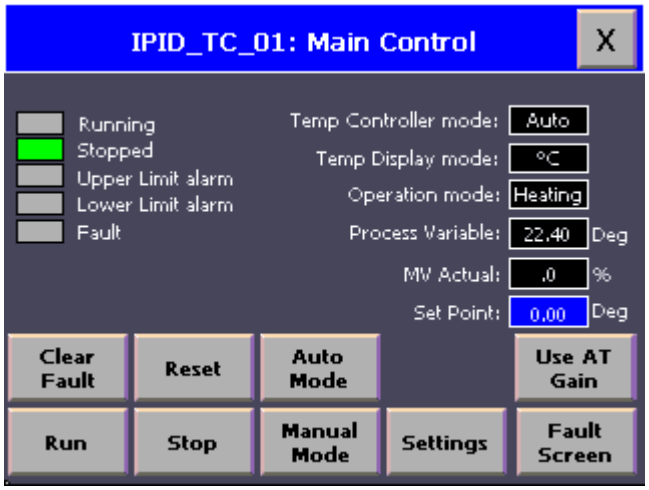
4. Press 'X' to return to the Auto Tune screen.
5. Press Auto Tune to execute the Auto Tune process.

   When the process completes successfully, PID parameters are generated and displayed on the Auto Tune screen.

Test the Auto Control Mode

Follow these steps to verify that the Auto Control mode works properly.

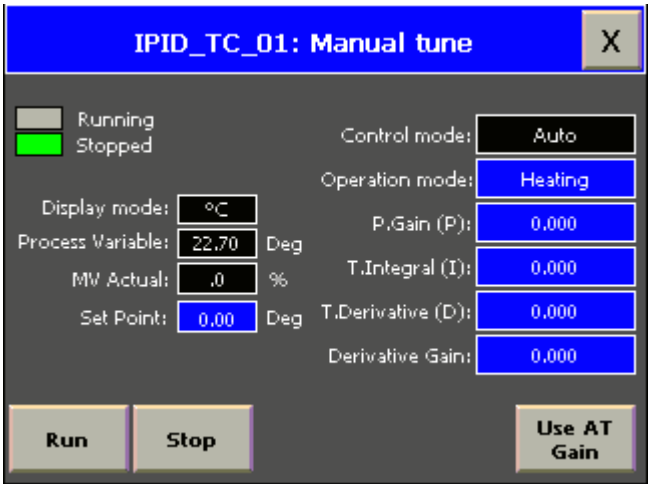
1. On the Main Control screen, press Auto Mode.
2. Verify that the Temp Controller mode changes to 'Auto' and the 'Set Point' input box appears.



3. If your initiated Auto Tune is successful, press Use AT Gain to update the gain with the Auto-tuned gain parameters, and proceed to step 4.

   If your initiated Auto Tune is unsuccessful, follow these steps.

   a. Press Setting to access the Manual Tune screen.
   b. Set or adjust the PID parameters.
   c. Enter a set point and observe the process behavior.
   d. Continue to adjust the PID parameters until the process is stable.
   e. Press X to return to the Main Control screen.



4. Enter a set point.

TIP You do not need to re-enter the set point in the Main Control screen if you already entered one in the Manual Tune screen.

Notes:

PID Temperature Control User-defined Function Blocks

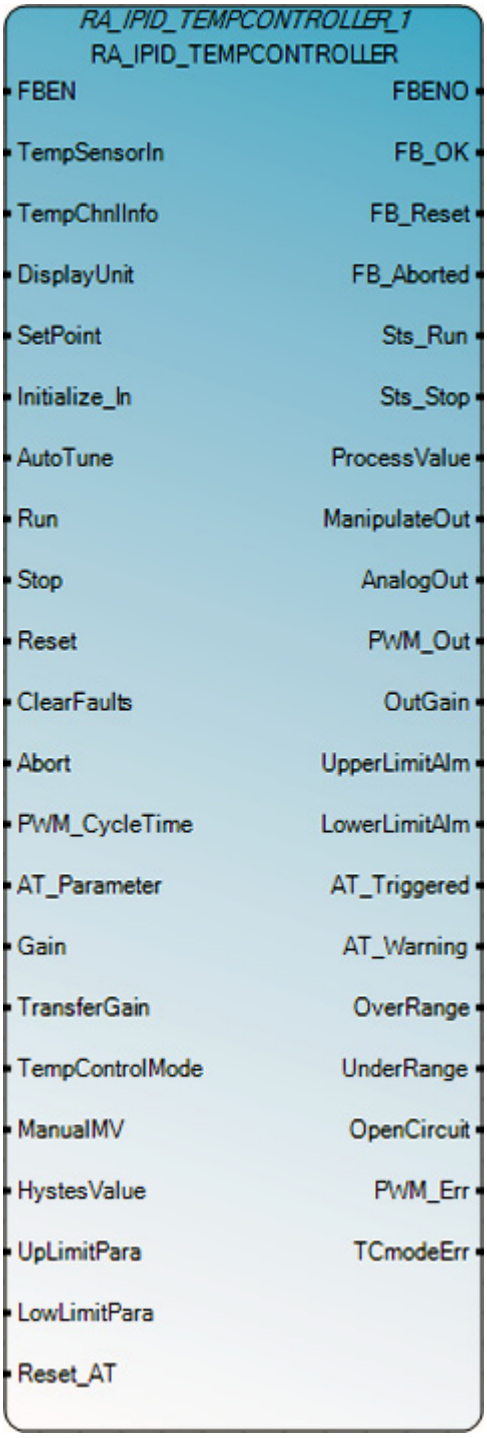
This appendix describes the available user-defined function blocks, and the associated inputs and outputs.

RA_IPID_TEMPCONTROLLER User-defined Function Block

This user-defined function block (UDFB) controls temperature through direct temperature input with analog and/or PWM output. The UDFB has the following features:

- Heating or cooling control
- Auto tuning
- Manual tuning
- Hysteresis function
- Display in Celsius or Fahrenheit mode
- Upper and lower limit alarm
- Detect temperature sensor break
- Run or stop operation
- Auto or Manual mode

Figure 7 - RA_IPID_TEMPCONTROLLER User-defined Function Block



The following inputs are provided in this UDFB file.

Table 19 - RA_IPID_TEMPCONTROLLER Inputs

Variable	Data Type	Description
FBEN	BOOL	Set this bit TRUE to enable the function block.
TempSensorIn	UINT	For 2080-RTD2 or TC2 temperature input.
TempChnlInfo	UINT	For 2080-RTD2 or TC2 temperature information input.
DisplayUnit	BOOL	Set this bit TRUE for Fahrenheit. Set this bit FALSE for Celsius.
SetPoint	REAL	This value enumerates the setpoint configured on the temperature controller.
Initialize_In	BOOL	A change in value (TRUE to FALSE or FALSE to TRUE) causes the controller to eliminate any proportional gain during that cycle. It also initializes Auto Tune sequences.
AutoTune	BOOL	Starts Auto Tune sequence.
Run	BOOL	Set this bit TRUE to enable control output.
Stop	BOOL	Set this bit TRUE to disable control output.
Reset	BOOL	Set this bit TRUE to initialize control output.
ClearFaults	BOOL	Trigger this bit to reset function block error.
Abort	BOOL	Trigger this bit to abort temperature control.
PWM_CycleTime	UINT	This value enumerates the time in milliseconds for a PWM cycle.
AT_Parameter	AT_PARAM	For Auto Tune parameters.

Parameter	Type	Description
Load	REAL	Initial controller value for Auto tuning process.
Deviation	REAL	Deviation for auto tuning. This is the standard deviation used to evaluate the noise band needed for Auto Tune (noise band = 3* Deviation)(1)
Step	REAL	Step value for Auto Tune. Must be greater than noise band and less than ½ load.
ATDynamSet	REAL	Auto Tune time. Set the time to wait for stabilization after the step test (in seconds). The Auto Tune process stops when ATDynamSet time expires.
ATReset	BOOL	Determines whether the output value is reset to zero after an Auto Tune sequence: • True – Reset IPIDCONTROLLER output to zero after Auto tune process. • False – Leaves output at load value.

(1) Estimate the value of 'ATParams.Deviation' by observing the process value (PV). See Table 15 on page 41 for more about Auto Tune parameters.

Gain	GAIN_PID	For IPIDCONTROLLER gains. See 'GAIN_PID' in Table 20 on page 50.
TransferGain	BOOL	Set this bit TRUE to transfer the new gain.
TempControlMode	INT	This value enumerates the preferred Temperature Control mode: • 0 - Auto • 1 - Manual • 2 - Auto Tune
ManualMV	REAL	This value enumerates the set point for the Manual Control mode.
HystesValue	REAL	This value enumerates the hysteresis if required by the operation.
UpLimitPara	REAL	This value enumerates when the upper limit alarm is triggered.
LowLimitPara	REAL	This value enumerates when the lower limit alarm is triggered.
RSET_AT	BOOL	Set this bit TRUE to reset when the Auto Tune Control mode fails.

IMPORTANT **Set** = Press and hold a button. The logic remains TRUE as long as you hold the button.
Trigger = Press and release a button. The logic is set to TRUE momentarily and returns to FALSE.

The following outputs are provided in this UDFB file.

Table 20 - RA_IPID_TEMPCONTROLLER Outputs

Variable	Data Type	Description
FBENO	BOOL	This bit is TRUE when the function block is enabled.
FB_OK	BOOL	This bit is TRUE when there is no error for temperature control.
FB_Reset	BOOL	This bit is TRUE when reset is triggered.
FB_Aborted	BOOL	This bit is TRUE when abort is triggered.
Sts_Run	BOOL	This bit is TRUE when output is operating.
Sts_Stop	BOOL	This bit is TRUE when output is not operating.
ProcessValue	REAL	This value enumerates the temperature in Celsius or Fahrenheit.
ManipulateOut	REAL	This value enumerates the IPID output between 0.0 and 100.0.
AnalogOut	UINT	This bit is TRUE for analog output.
PWM_Out	BOOL	This bit is TRUE for digital output.
OutGain	GAIN_PID	For gains calculated from the Auto Tune sequence. **Parameter** / **Type** / **Description** DirectActing / BOOL / Types of acting: • True – Direct acting • False – Reverse acting ProportionalGain / REAL / Proportional gain for PID (>0.0001) TimeIntegral / REAL / Time integral value for PID (>0.0001) TimeDerivative / REAL / Time derivative value for PID (>0.0) DerivativeGain / REAL / Derivative gain for PID (>0.0)
UpperLimitAlm	BOOL	This bit is TRUE when the upper limit threshold has been triggered.
LowerLimitAlm	BOOL	This bit is TRUE when the lower limit threshold has been triggered.
AT_Triggered	BOOL	This bit is TRUE when Auto Tune Control mode is in process.
AT_Warning	INT	This value enumerates Auto Tune Control mode status: • -2: Auto Tune unsuccessful, the 'ATDynaSet' time (duration) has expired • -1: Controller input "AUTO" is TRUE, please set to FALSE • 0: No Auto Tune • 1: Auto Tune in process • 2: Auto Tune successful (completed)
OverRange	BOOL	This bit is TRUE when input exceeds the maximum set value. The channel temperature data shows maximum temperature count for the sensor used and the value does not change until the over range error is cleared.
UnderRange	BOOL	This bit is TRUE when input drops below the minimum set value. The channel temperature data shows minimum temperature count for the sensor used and the value does not change until the under range error is cleared.
OpenCircuit	BOOL	This bit is TRUE when there is an open circuit on the channel input sensor.
PWM_Error	BOOL	This bit is TRUE when there is a PWM error.
TCmodeErr	BOOL	This bit is TRUE when there is a Temperature Control mode error.

RA_IPID_TEMPCONTROLLER User-defined Function Block (UDFB) Operation

This UDFB is designed to generate an output after the function block (FB) considers the set point (set temperature) and process value (current temperature). The output drives an internal mechanism to provide a PWM output and/or analog output (PLC digital and analog output).

This is an error checking function in the UDFB to verify that setting and configuration are done properly. Otherwise, there is no output and the error bits become TRUE. Therefore, it is important that all error status ('PWM_Err' and 'TCmodeErr') is off (set to FALSE). If any are TRUE, check if that fault has been configured properly.

EXAMPLE 'TCmodeErr' becomes TRUE when the mode input is invalid—control output is disabled and control resumes only when the error is cleared.

There are five basic parameters that must be configured properly for the UDFB to generate an output:

- Set point
- Temperature Display mode
- Controller Operation mode
- Heating or Cooling mode
- Run or Stop mode

Once these five basic parameters have been defined and with a temperature feedback, the UDBF generates an output to control the system.

Notes:

Global Variables

Table 21 - Global Variables Used for User Program Interfacing

Variable	Data Type	Description
TC1_Cfg_Cool_Heat_Mode_Auto	BOOL	Set to TRUE for cooling application. Set to FALSE for heating application.
TC1_Cfg_DisplayUnit_Auto	BOOL	Set to TRUE to display temperature in Fahrenheit. Set to FALSE to display temperature in Celsius.
TC1_Cmd_ClearFaults_Auto	BOOL	Set to TRUE to clear fault.
TC1_Cmd_Ini_Auto	BOOL	Trigger to initialize control output.
TC1_Cmd_Run_Auto	BOOL	Execute to start the temperature control loop.
TC1_Cmd_Stop_Auto	BOOL	Execute to stop the temperature control loop.
TC1_Cfg_DervGain_Auto	REAL	Set the derivative gain for temperature control.
TC1_Cfg_HysVal_Auto	REAL	Set the hysteresis value for temperature control.
TC1_Cfg_LowLimit_Auto	REAL	Set the lower temperature limit.
TC1_Cfg_ProGain_Auto	REAL	Set the proportional gain value for temperature control.
TC1_Cfg_TimeDerv_Auto	REAL	Set the time derivative value for temperature control.
TC1_Cfg_TimeIntgrl_Auto	REAL	Set the time integral value for temperature control.
TC1_Cfg_UpLimit_Auto	REAL	Set the upper temperature limit.
TC1_Cmd_Set_Point_Auto	REAL	Set the command temperature value.
TC1_Cfg_PWM_CycTim_Auto	UINT	Set the cycle time (ms) for the PWM.
TC1_Sts_UpLimit_alm	BOOL	This bit is TRUE when the process value is higher than the upper limit setting.
TC1_Sts_LowLimit_alm	BOOL	This bit is TRUE when the process value is lower than lower limit setting.
TC1_Sts_OK	BOOL	This bit is TRUE when the temperature controller is ready to run.
TC1_Sts_Man_Auto_Mode	BOOL	This bit is TRUE when there is a PWM error.
TC1_Sts_AutoTuneMode	BOOL	This bit is TRUE when the temperature controller is in Manual mode. This bit is FALSE when the temperature controller is in Auto mode.
TC1_Sts_Cool_Heat_Mode	BOOL	This bit is TRUE when the temperature controller is in the Cooling mode. This bit is FALSE when the temperature controller is in the Heating mode.
TC1_Sts_PWM_Err	BOOL	This bit is TRUE when there is an error for PWM configuration.
TC1_Sts_TC_Mode_Err	BOOL	This bit is TRUE when there is an error for Temperature mode configuration.
TC1_Sts_Running	BOOL	This bit is TRUE when the temperature controller is operating.
TC1_Sts_Stopped	BOOL	This bit is TRUE when the temperature controller is stopped.
TC1_Sts_OverRange	BOOL	This bit is TRUE when the input value exceeds the upper limit of sensor capacity.
TC1_Sts_UnderRange	BOOL	This bit is TRUE when the input value exceeds the lower limit of sensor capacity.
TC1_Sts_OpenCircuit	BOOL	This bit is TRUE when there is a possible wire break between the sensor.

Table 21 - Global Variables Used for User Program Interfacing (continued)

Variable	Data Type	Description
TC1_Sts_Tf_Tc_Mode	BOOL	This bit is TRUE when the display unit is in Fahrenheit. This bit is FALSE when the display unit is in Celsius.
TC1_Sts_AT_Warning	INT	This value enumerates Auto Tune Control mode status: • -2: Auto Tune unsuccessful, the 'ATDynaSet' time (duration) has expired • -1: Controller input "AUTO" is TRUE, please set to FALSE • 0: No Auto Tune • 1: Auto Tune in process • 2: Auto Tune successful (completed)
TC1_Sts_ControlValue	REAL	This value returns the PID output value.
TC1_Sts_TempValue	REAL	This value returns the current temperature.
TC1_Sts_TimeIntgrl	REAL	This value returns the current time integral value.
TC1_Sts_TimeDerv	REAL	This value returns the current time derivative value.
TC1_Sts_ProGain	REAL	This value returns the current proportional gain value.
TC1_Sts_DervGain	REAL	This value returns the current derivative gain value.
TC1_Sts_AT_WaitTime	UDINT	This value returns the Auto Tune wait time in seconds.

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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